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THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

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THE TROUBLES OF A TRAMWAY.

AFTER Mr. Elmer E. Cook's naïve paper on how trucks have been constructed up to the present time, the trouble between the L.U.T. and the Ealing T.C. will not surprise even those who have been happy hitherto in the belief that all trucks are alike and all equally good.

Upon complaints long and loud received from the Ealing Council, the B. of T. instructed Colonel Yorke to report upon their substance, and the publication of that report will cause those most careless in finance to give closer heed to the plain statements as to the overweighted condition of the L.U.T. Co., which have appeared in our columns from time to time, while it may bring home to all who are interested in tramways from a financial or an engineering standpoint, the grave outlook which confronts any system which has not been constructed and maintained on the soundest lines, and on which the cars have been built more with a view to beating back American competition than to long and comfortable lives.

Briefly, Colonel Yorke found the complaints of intolerable noise substantiated. In the first place, the bogie trucks rattled and clattered in the way which tramway managers know well, then the rails are corrugated in places, and, lastly, the rail joints are low.

The life of the wearing parts on the vast majority of trucks on our tramways, no matter if they be bogie or single trucks, is not more than five years where the conditions of service are at all severe, and that state of thing is the immediate consequence of shoddy construction. Had all wearing surfaces been designed with ample area, had they been made of suitable material properly hardened, and had the finish of those surfaces and of all bolts and bolt-holes been transferred from the smithy to the machine shop, dividends would have been increased, the sleep of frontagers would have been undisturbed, and the worries of engineers and managers would have been diminished many fold.

As it is the frames hog, the brake-gear requires renewal every three to six years, the journal boxes have to be tinkered up or scrapped in the same period, the horn-plates wear beyond all reason, and a dozen other things happen which the British tramway truck maker never foresaw, or, foreseeing, allowed to happen.

The end of it all is tribulation, either with or without a report from the B. of T. The L.U.T. took theirs "with."

The origin of corrugations is accepted still as veiled, although there are some workable suspicions about it. Col. Yorke prefers not to commit himself, and we may be content for the time with the knowledge that however they come about, they may be removed by means of emery grinding machines, although the Ealing surveyor says, in a report to the Council, that he "saw the machine at work, but as to the beneficial results arising from its use, one has failed to discover them. On the other hand, the annoyance to residents on the line of route when the machine is at work at night, is almost unbearable." Possibly these words were written in the anger of his heart, for there are grinding machines that will do the work. It remains to be seen how soon the corrugations take to re-appear, for it is hard to believe that any amount of grinding can remove the cause of the corrugations, if such resides in the rail or its environments.

Low joints and disturbed paving by no means come within the category of mystic origins. Whenever they occur, we may be sure that advantage has not been taken of common

knowledge, and that the original work of rail-laying was not executed with the particular care which such work demands. Given rails well founded on good concrete, given anchors between joints and sole-plates worthy of the name at joints, given paving laid level and solid in waterproof and elastic jointing, and given common-sense treatment of repairs when they become necessary, no trouble of any kind, except corrugation, can arise during the useful life of rails or paving. Given the opposite, and, very much too soon for everyone but the day labourers, most of the work has to be done over again, and this L.U.T. business is a good reminder that when once repairs start they are never-ending, unless they proceed on lines which seem to be too much out of the ordinary course.

We mentioned sole-plates above. Girder sole-plates and the best of patent joints will make a sound and lasting job, but the welded joint has come to stay, and the sooner that is recognised by everyone the better for all.

Illuminating Engineering.

Last May we referred to an aspect of the question of efficiently lighting enclosed spaces by electricity, and pointed out that there was ample room for an expert on illuminating. Since then the attention of others has been drawn to the fact that electric lighting is often done in a manner utterly regardless of the effect on the eye so long as the floor receives its due quota of candle-power or watts per square foot. Even in America, where it may truly be said that æsthetics have a poor chance in the strenuous life and (to use a colloquialism) art has to take a back seat, it has at length been recognised that a room or hall is not necessarily efficiently lighted by "hitting" lamps promiscuously about on the ceilings. In a paper recently read by Mr. James R. Cravath before the Western Society of Engineers in Chicago, a number of local electrically-lighted halls, &c., were, metaphorically, pulled to pieces. Lantern slides, clearly showing the faulty methods of lighting, were used to assist the vigorous criticisms of the author, who boldly advocated the recognition of illuminating engineers. The function of these experts should be to work together with the architect, in order that the attainment of artistic designs should not be achieved at the expense of illuminating efficiency.

Mr. Cravath, in dealing with public halls, recommended the extensive use of hidden lamps with reflectors; or, where the lamps are on fittings which form part of the artistic design, that the light should be filtered through holophane globes or opal glass saucers. In dealing with private rooms, he instanced the faulty illumination obtained by fixing bare lamps against a ceiling of oak beams, now so much the fashion amongst those who have the old Dutch mania. He rightly points out that consumers who have such rooms can well pay for more current by using reflected or diffused light. But what about the poorer consumer? Mr. Cravath says that a small living room can be efficiently lighted by an electrolier having two spreading arms with holophane globes for general lighting, and one centre light pointing vertically downward with a prismatic glass reflector. He advocates the use of the latter for reading instead of a table lamp, where most of the light is wasted on the table. Such were a few of the suggestions made, but the paper was chiefly of value in regard to the number of examples shown by means of slides. Those who took part in the discussion rather skimmed the subject, as apparently the point of view was a novel one to most engineers. But the agitation of which this paper was one of the signs, has caused definite action to be taken. Last month in New York there was organised the Illuminating Engineering Society: officers were elected, rules adopted and 89 members enrolled from amongst electrical engineers, gas engineers and architects. Is it not time that something of the sort were done here, where it is no extravagant claim to make that architecture and art are more revered than in the United States? As regards the methods of lighting available, it seems to us a mistake to rely solely nowadays on the small-bulb incandescent lamp, whose source of light is too small for good diffusive purposes. We now have the large bulb high efficiency lamps, Nernst, Osmium and Tantalum lamps, all of which are much better adapted for diffused or hidden lighting in private houses; whilst for larger rooms and halls the same lamps may be used, with or without miniature or large enclosed arc lamps, to give an economical and soft light, quite unattainable with the ordinary incandescent lamp.

The Single-Phase Induction Motor.

We strongly commend to the notice of our readers the article by Mr. Val. A. Fynn which commences in this issue, and which, for the first time, we believe, presents the theory of the single-phase induction motor in a simple and intelligible form without the use of complicated diagrams and mathematics.

About some Cables at Walthamstow.

For many months past there has been a good deal of lively discussion at Walthamstow centring round certain actions of the District Council's electrical engineer, Mr. J. H. Fooks Bale. This gentleman has been accused of making irregular purchase of cable from a local firm at an unnecessarily excessive figure when there was running a contract between the Council and a well-known cable manufacturing company, under which the price paid would have been considerably less. The purchase was declared to be unauthorised by the Committee, and the minutes certainly contained no entry of special authorisation having been granted for the running contract to be departed from. When pressed to state why this higher priced order had been given, the engineer argued that he got a superior quality cable, but this he appears to have subsequently withdrawn, substituting for it a statement that the quality was the same, but the price would work out cheaper. These, and other conflicting statements, were made by Mr. Fooks Bale when he was questioned by Mr. Councillor Hawley. After many discussions, the Council asked the Councillor to state his charges against Mr. Fooks Bale in writing, and the engineer was to reply in the same way. Those who are interested in the matter will find the charges, and the reply thereto, printed *in extenso* in the *Walthamstow & District Times* for February 2nd. In this same paper, a copy of which is before us, they will also find a report of the somewhat exciting discussion which took place before the engineer's statement was forthcoming. We have read this through from beginning to end, and whatever other feelings we may have on the matter, we must strongly deprecate the efforts which were made to defer the hearing and consideration of the reply. The charges were sent to the Clerk on January 9th, the Lighting Committee met on January 12th, but though, as later appeared, Mr. Bale's report was ready, every obstacle seemed to be put in the way of consideration of the matter at a Council meeting held on January 26th. One of the first thoughts suggesting themselves would be that when a charge of irregularity was made against an engineer he and his committee would be anxious to disprove it at the earliest possible moment, and not lay themselves open to any further accusation. There it is however,—a special resolution of the Council had to be passed to secure the reading of Mr. Bale's reply on 26th ult. As to this reply itself we regret that we cannot congratulate the engineer upon the adoption of a dignified attitude. He would have been better advised had he given a briefer explanation, omitting certain uncalled-for personal remarks respecting those who have been trying in the interests of the borough to get a matter, around which there was more or less mystery, cleared up. He should have answered the charges made against him by statements of fact, and not by self-praise and by abuse of an opponent.

We are not astonished to find that some of the members of the meeting expressed themselves dissatisfied with his statement, and resolved that the matter should be still further investigated by the Lighting Committee, copies of both statements being sent to each member of the Council. It seems to us that there are points of technical significance which the Committee may not be able to adjudicate upon. Would it not be far more satisfactory to refer the question to some independent authority? It is quite true that the contract was "only a little one," but we have heard that said in another interesting connection.

A CONTRIBUTION TO THE THEORY OF THE SINGLE-PHASE INDUCTION MOTOR.

By VAL. A. FYNN.

The history of the asynchronous single-phase induction motor has been from the very beginning a most fascinating one. Discovered by accident somewhere about the year 1890, the machine has done much useful work ever since; but, if one may judge by quite recent publications, its theory is by no means clear even to this day. Quite a number of theories have been advanced from time to time by the best known exponents of the electrical profession, but none of these seem to have been universally accepted. This state of things must be the author's excuse for adding yet another contribution to the already long list of publications on the subject of single-phase induction motors. The theory which will be here set forth is really an extension, although a very wide one, of a theory outlined as far back as 1898 by Ll. B. Atkinson; and it will be followed by a number of deductions drawn by the author, which, it is hoped, will not only be of interest, but will also open out fresh fields for the commercial applications of such machines, and will, in a general way, help to fix ideas as to the nature of single-phase motors.

It is never advisable to try and deduce a general theory for any machine whilst basing one's considerations on a special form of that machine, and it is for this reason that the well-known "squirrel cage" rotor, or the rotor provided with a polyphase winding connected to slip rings, will be discarded for the moment, resort being had to the most general, and what the author considers to be the fundamental, form of the single-phase induction motor. This comprises a stator, energised by the winding S, and a rotor R, in the shape of an ordinary continuous-current armature, but short-circuited by means of the brushes C C and D D along two axes which are stationary in space and (for a two-pole motor) perpendicular to each other, whilst one of them coincides with the stator-field axis, as is shown diagrammatically in fig. 1.

This diagram, and all the following ones, represent two-pole machines, while throughout, except where otherwise stated, the armature winding is supposed to be of the Gramme ring type, with the brushes bearing directly on that winding.

A machine as indicated in fig. 1 has all the characteristics of the single-phase induction motor. If switched on to the circuit when standing still, it will not start by itself, but will take a very heavy current. If, by some means or other, it is given a sufficient initial impetus in the one or other direction, it will run up to its normal speed, equally well in either case. The nearly synchronous will be its limiting speed, and at no load it will very closely approach synchronism. As the load increases the asynchronism will also increase, and when sufficiently overloaded this motor will suddenly fall out of step and come to a standstill.

Means for starting such motors have been described by the author elsewhere; for our present purpose it will suffice to assume that the motor *has* been started, our task being to show why and how it continues to run, how it is able to exert a torque, and why it runs in either direction, and at a constant and nearly synchronous speed.

What takes place when the motor has been started is briefly as follows:—

The stator winding S produces in its axis an alternating field; the rotor R being short circuited by the brushes C C along that same axis acts like the secondary of a transformer whose primary is represented by S. An E.M.F., lagging by 90° behind the transformer field, is consequently induced in the rotor along the axis C C, which will hereinafter be referred to as the transformer axis, and this E.M.F. tends to set up a heavy current in the rotor. Because of the rotation of the rotor conductors in the transformer field, an E.M.F. is generated along the axis D D, and this E.M.F., which must be in phase with the transformer field, acting on the closed circuit in this axis, gives rise to a current, the magnetising component of which lags 90° behind its E.M.F., and produces a field sensibly cophasal with itself, and consequently displaced with regard to the transformer field by 90° both in phase and in space. Conversely, because of the rotation of the rotor conductors in the field along D D, an E.M.F. is generated in the rotor along the axis C C in phase with the field producing it, therefore displaced by 90° with regard to the transformer field, and consequently in phase with the E.M.F. statically induced in that axis, but of opposite direction to it. When these two E.M.F.'s balance, there will be no current flowing in the rotor axis C C; if, for instance, the E.M.F. due to rotation is smaller than that due to transformation or static induction, then a current will flow, and it will lag behind its E.M.F. much as the secondary current in a poor transformer lags behind the secondary E.M.F. when working on a circuit possessed of some self-induction. Now the torque which the motor is able to exert is due to the interaction of the rotor current in the transformer axis, and the field in the axis D D which hereinafter will be referred to as the motor field. These two are very nearly in phase, and in the most advantageous relative position in space for the production of a torque.

Before entering upon a detailed consideration of the various actions involved, and in the hope of making it easier to follow his arguments, the author wishes to emphasise at once that in the motor just described we really have a reproduction, although in a somewhat unusual form, of those very same conditions which obtain in an ordinary continuous current motor and determine its operation. The transformer field is not, of course, to be found in a continuous current machine. In the alternate current motor it does no directly useful work, but is nevertheless of the greatest importance to any machine of that class possessing a shunt characteristic. By means of this transformer field the working E.M.F. hereafter designated by E T is inductively impressed on the armature, or rotor, along the axis C C, and corresponds to the working E.M.F. impressed on the brushes of

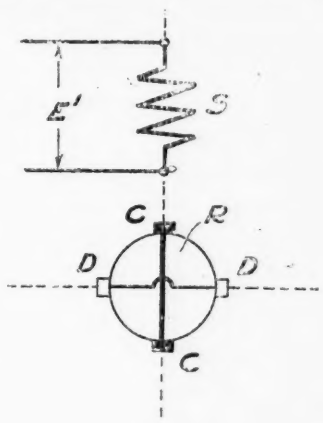


Fig. 1.

the continuous current motor. By the same means the working current is conveyed into the armature along the same axis, by induction instead of conduction, and it is very important to note that this current can be varied within the widest limits without bringing about an appreciable variation in the strength of the transformer field provided, of course, the E.M.F. impressed on the stator winding be kept constant. As in the ordinary transformer, the resultant of primary (or stator) and secondary (or rotor) ampere-turns will always be equal to the no-load ampere-turns, and will remain practically constant for all loads, so that the magnetising component thereof, and with it the transformer field, will also remain practically constant. This transformer field is also responsible for the E.M.F. which is impressed on the field winding of the motor. This E.M.F. is set up, as has been explained, along the axis D D, and by rotation of the armature conductors in the transformer field; it corresponds to that E.M.F. in continuous current practice, which is impressed on the field winding and which is generally derived directly from the supply. In this motor, however, there is no distinct field winding; the armature conductors themselves do duty as such, the exciting current being introduced along the axis D D, displaced by $\frac{180}{n}$ degrees with regard to the

armature axis C C (*n* is here throughout taken to represent the number of poles of the machine). Finally, the back E.M.F., hereafter designated by E B, which is set up in the axis C C owing to the rotation of the armature conductors in the motor field, and which in the alternate current motor prevents the transformer in the axis C C from being short-circuited, corresponds to the back E.M.F. generated in the same manner in the continuous current motor.

Turning back to the theory briefly stated at the outset, a closer investigation of the more important factors concerned may be of interest. The E.M.F. generated in the rotor along the axis C C by transformer action from S, to which we will refer as E T, depends for its period and magnitude on the period and on the magnitude of the transformer field, and is quite independent of the rotation of the conductors in which it is generated; it will therefore always have the periodicity of the supply. The E.M.F. generated in the rotor along the axis D D by rotation in the transformer field, to which we will refer as E R, depends for its magnitude on the magnitude of the transformer field, and on the speed of rotation. Its periodicity will be the same as that of the transformer field, independently of the speed at which the motor revolves; it will therefore always have the periodicity of the supply. The motor field, which depends on E R, will therefore always have the same periodicity as the transformer field, and that being so, the E.M.F. generated in the rotor along the axis C C by rotation in the motor field, to which we will refer as E B, will depend for its magnitude on the magnitude of the motor field and on the speed of rotation; its periodicity, however, will be the same as that of the motor field, independently of the speed of rotation, and it will therefore have the same periodicity as the supply, and the same periodicity as E T, to which it is opposed.

Dealing now with the phase relation of the various factors, it is easy to see that E T will be nearly co-phasal with E^1, the E.M.F. which is impressed on the stator winding, and will lag behind the transformer field by 90°; E R being co-phasal with this field, will set up a magnetising current in the axis D D, which will lag by 90° behind E R, and it will therefore be displaced by 90° as regards phase with respect to the transformer field. This magnetising current is responsible for the motor field, and the phase of the latter will consequently be displaced by practically 90° with regard to the phase of the transformer field. This displacement will not be exactly to the extent of 90°, because of the fact that a field is not absolutely co-phasal with the magneto-motive force to which it is due; but we will not take these small differences into account here. The back E.M.F. (E B) is, however, co-phasal with the motor field, and, omitting sign, consequently also very nearly co-phasal with E T, to which it is opposed.

The small E.M.F. in the rotor axis C C, which coincides in phase with, and determines the magnitude of, the working or armature current of the motor, is the resultant of a number of the E.M.F.'s acting in that axis, and goes to cover the ohmic loss in the rotor conductors; we will call it E W. The component E.M.F.'s which determine the phase and the magnitude of the resultant E W in the axis C C are first of all E T and E B, which are nearly equal, and nearly opposed in phase: a third component E S is a small E.M.F. of self-induction, the phase of which lags 90° behind the rotor current, and whose presence is principally due to the fact that there is of necessity a very appreciable amount of magnetic leakage between the secondary and the primary of the transformer in the axis C C. The net result is that the working current will lag considerably behind E T, and, since this rotor current flows in the secondary of a transformer, the current in the primary thereof must always tend to place itself, as regards phase, in opposition to the former, and consequently the stator current will lag behind the E.M.F. impressed on the terminals. The working current not being in phase with E T, is also not quite in phase with the motor field, and this condition does not only lead to a poor power factor, but also to a somewhat reduced maximum torque.

This theory can be applied, as it stands, to the well-known motor, with totally short-circuited rotor. As is now evident, a single-phase induction motor, in order to work at all, must have a rotor short-circuited at least along two axes, as shown in fig. 1, but it is equally easy to see that the number of axes along which such a rotor can be short-circuited without modifying or impairing its operation, can be increased. By continually increasing the number of these axes, we finally arrive at a rotor whose commutator is entirely covered with brushes or totally short-circuited; such a rotor obviously requires no commutator, and its simplest practical form is known as the "squirrel cage" rotor.

(To be continued.)

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Electrolytic Lead Poisoning.

As Mr. Baldwin Latham's paper on the case of lead poisoning at Twyford, Hants, has caused some discussion in the electrical Press, notably the *Electrical Times*, the *Electrician*, and your own paper, and as the editor of the *Electrician* seems to be the only one that has appreciated the main point, perhaps you will allow me, as my firm were responsible for part of the tests contained in the paper, to point out certain errors into which the critics, in their natural anxiety to defend electricity, have fallen.

I am surprised that a scientific paper of your standing should discuss a subject with so little dignity, while exhibiting so much ignorance of the laws of electrolysis, to say nothing of the facts of this particular case.

There was evidence of electrolysis on the outside of the pipe I examined in the ground near where the worst section was cut out; the lead was pitted externally, and there was a slight deposit similar in appearance to that inside, but owing to the chalky and sodden nature of the ground, the carbonate of lead would be dissolved away nearly as fast as formed (the sections cut out had been much handled, and even when I saw them, before the reading of the paper, were becoming polished on the outside).

The internal deposit was certainly of a nature to suggest electrolysis; it is stated in the paper and in our report that there was deposit in the old pipe, but to a smaller extent.

The lead of the pipe in question was found to be practically pure; good commercial lead is commonly 99·9 per cent., or even more.

The conditions for electrolysis were complete, and the case was one which the regulations of the Board of Trade for central stations were especially drawn to prevent.

In the case of lead, where the metal is positive to the electrolyte, any E.M.F. applied to the lead, when the lead is made positive, is sufficient to dissolve any quantity of metal, irrespective of the quantity of current, provided there is time. There is no opposing or critical E.M.F. as in electro-deposition; on the contrary, any E.M.F. due to the system acting as a cell will assist the applied E.M.F.

The strip used as a return conductor in this installation was partially and badly connected to earth at the engine house, and dead earthed to the particular water pipe in question at the house some distance off. We did not measure the drop in volts on this strip, as stated in your article, but measured the P.D. between the pipe outside the engine house and the strip at the engine house, when 30 amperes were passing through the strip; this was found to be 1·8 volts.

There were only a few feet of wet earth, and a damp brick culvert, between the pipe and a considerable surface of the strip before it entered a bitumen trough; the new pipe was connected to the old pipe at a joint just outside the engine house. There will always be some potential difference between the pipe and this strip, whatever current is passing through the strip, and the pipe will, as was found by test, be positive.

Now, as the strip was directly connected to the pipe at its furthest point in the house, and as the pipe was earthed near this point, the pipe and the strip running nearly parallel, the P.D. will increase the further the pipe runs away from the house, as was actually found to be the case, consequently the electrolysis will be greatest at the furthest end, where it was found. Moreover, this part of the pipe

being new had no protective coating of oxide, as had the older pipe nearer the house.

The statement that the pipe as it ran out to a dead end "could by no possibility whatever form part of a return circuit for stray currents" is absurd, seeing that the pipe must be and was positive for electrolysis to occur.

Careful tests were made by the chemists with pieces of the actual lead pipe, and some of the actual water supplied to this district, and practically no solution took place until an electric current was passed, when a patchy deposit of carbonate of lead was formed as a crust *inside* the pipe, thus showing by actual experiment the exact effects that were found on the spot. There were no parallel lines of pipes that I am aware of, certainly not metallically connected to the copper strip return.

In conclusion, it would be interesting to know whether the author of the article in your paper, since he scouts the idea of 1·8 volts being sufficient to cause electrolysis, is acquainted with the E.M.F. of primary batteries, or that required in ordinary commercial electrolytic cells, or the laws of electro-chemistry, and for his benefit I would repeat any E.M.F. can electrolytically dissolve any quantity of lead, irrespective of quantity of current, provided there is *time*.

O. D. Lucas.
Owen Lucas & Pyke.

London, S.W., *February 2nd*, 1906.

[We have read our correspondent's letter with keen appreciation; we do not, as a rule, derive much amusement from such literature. He that is dizzy thinks the world turns round; and Mr. Lucas is convinced that his critics are all wrong.

The mere fact that carbonate of lead was discovered in patches inside the pipe is no proof whatever that electrolytic corrosion had taken place; it is the natural product of the corrosion of lead by water containing carbon dioxide. Moreover, it is practically insoluble, though Mr. Lucas thinks it was dissolved off the outside of the pipe nearly as fast as formed. Why did it not occur to him that it would just as easily be dissolved off the inside of the pipe, which was at least as wet as the outside? There was nothing about the deposit to suggest electrolytic action; it looked more like local action, and be it remembered that this is as likely to be caused by loose particles of foreign matter resting inside the pipe, as by impurities in the substance of the pipe, so that the purity of the lead does not help his theory. Such particles would be carried along in the water, and would accumulate where the rate of flow was a minimum—in a dead end, or nearly dead end, such as the pipe in question. There is, indeed, no need to postulate the presence of such particles; copper and brass are strongly electro-negative to lead, and was there not a brass tap on the pipe? We could bring forward examples of precisely similar solution of lead in a seldom used water pipe, if necessary; and we have ourselves made experiments proving that lead in contact with brass in pure drinking water is attacked, whilst lead alone is not affected. There is no need to call in stray currents to account for the lead poisoning.

But let us inquire into the case again. Were the conditions for electrolysis complete? As for the Board of Trade regulations for central stations, they do not apply to this case; but where they call for earthing a conductor, they rightly specify that it shall be earthed at *one place only*. This condition was fulfilled at Twyford. The return conductor was earthed to the pipes at the house, 200 or 300 yds. from the cottage, but was not earthed at the engine room, where, in fact, a resistance of eight ohms was found between the return conductor and earth (we are not told whether the earth connection was cut before making this test; we wonder!). Hence, as we stated in our leaderette, Messrs. Lucas and Pyke *did* measure the drop of pressure in the strip, for the lead pipe acted merely as a voltmeter wire to the far end of it. But now, what says the paper? "The earth immediately under and round the engine house showed a positive charge as compared with the pipes running away from this house" of the order of 0·2 volt. Messrs. Lucas and Pyke stated that this would not be sufficient to account for the electrolysis that had occurred, and it was well that they did so—for the E.M.F. was in the wrong direction to injure the pipes. The current—if there were any—must have been flowing from the earth to the pipes. Let us proceed—"the potential of the ground immediately surrounding the engine house was distinctly above that of the nominal earthed return main, but again not amounting to more than 0·2 of a volt." Obviously, then, the earthed conductor and the pipe were at the same potential!

By sending the abnormal current of 30 amperes through the mains to the house, a drop in the return of 1·8 volts was obtained, and to this, which would only occur on festive occasions, was attributed the alleged electrolysis. The distance from the house to the engine-room is nearly 200 yards, and from the engine-room to the cottage about 100 yards further, so that if there were any stray current, it must have so far lost its way as to wander to the far end of a pipe 100 yards beyond its ultimate destination—the engine room—and there it fell into the water *inside* the pipe. Truly the vagaries of electricity are unaccountable. Was it the inertia of the current that carried it so far? And why should it go inwards when it got there, instead of finding its way back through the "chalky and sodden" ground round the pipe to the negative bus-bar, with its 8 ohms insulation resistance? We do not know the precise conductivity of the water in the pipe, but we may safely take it to have been less than one-millionth that of lead, while the cross-section of the lead in the pipe was three times that of the water; hence, if a current were to flow along the lead pipe, about $\frac{1}{3000000}$ of it would be carried by the water. The current could not exceed $\frac{1}{4}$ ampere, for the maximum voltage was 1·8, and the resistance was 8 ohms; Mr. Lucas may calculate how many amperes would flow in the water. If the current flowed across the pipe, at right angles to its length, the water would carry less than one-millionth of it, assuming that there were no polarisation. But why should it flow across the pipe? The only way in which electrolysis inside the pipe could be effected would be by the current going along the pipe, and returning by the water—whither?

Turning back for a moment, Mr. Lucas says that the P.D. between the pipe and the strip would increase the further they went from the house. Any current flowing along the pipe would produce a drop of voltage in the latter, and thus bring its potential nearer that of the conductor; the greater the current in the pipe, the less would be the P.D., and if the main had been earthed at the engine room, the P.D. would have been zero, the current in the pipe a maximum.

As for the experiments of the chemists, we challenge Mr. Lucas to deny that the electrolysis observed by them was produced by passing a current from the pipe to an electrode suspended *inside* the pipe! *In no other way could it be produced.*

Finally, we wonder whether our correspondent is aware that E.M.F. has nothing to do with electrolysis. It would seem not. What would Faraday have said to Mr. Lucas's assertion, that any E.M.F. can dissolve any quantity of lead, irrespective of "quantity of current, provided there is time?" Dear sir, the amount of electrolysis depends wholly upon the quantity of electricity—the ampere-hours—and has nothing at all to do with E.M.F.

Surely Mr. Lucas has seen a Leclanché cell, and knows that it has an E.M.F. of about $1\frac{1}{2}$ volts—yet there is no electrolysis unless a current flows. There has not been a particle of evidence brought forward to show that any current flowed in or near the pipes; the presence of E.M.F. proves nothing at all.—Eds. E.R.]

Claim by Apprentices.

My attention has only just been called to a paragraph which appeared in your issue of December 1st last under the above heading. I had not previously heard of the report quoted by you, and as it is not a fair report of what took place before the magistrate, I feel sure you will give me an opportunity of stating in your valuable paper the actual facts disclosed.

The apprentices referred to were, with others, by the consent of the Consolidated Electrical Co. and its predecessors articled to myself (as the general manager) and the works foreman jointly. The deeds were held by the company, who paid the apprentices wages and exercised full control over them.

I severed my connection with the Consolidated Electrical Co. about 18 months ago, and it was then arranged that the company should continue to be responsible to the apprentices, but no strict legal assignment of the indenture was executed.

About October last the Consolidated Electrical Co. purported to sell its manufacturing business to the Consolidated Supply Co., Ltd., who undertook to perform and carry out the contracts and obligations of the Consolidated Electrical Co. Although the latter company had retained all the apprentices, the new company decided to discharge some and retain others. The apprentices so discharged then made a claim against me, which I had formally to resist, so as to justify my claim to be indemnified by the Consolidated Electrical Co.

As to the statement that in three or four years the apprentices had learned practically nothing, I had them under my own supervision until I left the company, and gave them every assistance in teaching them their business—and how the boys benefited by that tuition is proved by the fact which has since come to my knowledge, viz., that within a few days of the hearing they all obtained situations at good wages.

The amount awarded in four of the cases was the exact proportion of the premium paid for the unexpired term, and in the fifth a much lower proportion.

Many of my late pupils are now occupying responsible positions, and some have obtained public appointments. In these circumstances I feel sure you will agree that the report you quoted is not a fair comment on what took place.

I trust you will give the same prominence to this letter in your valued paper as you did to the report.

Edward L. Joseph.

London, *February 1st*, 1906.

[The report in question, as stated at the time, was quoted from the *Daily News*.—Eds. E.R.]

Leakage Indicator.

In your current issue "Meter" asks whether I can recommend a method of measuring the leakage on a continuously earthed two-wire system. Unfortunately, as far as present knowledge goes, there is no really satisfactory means of doing this. The reason is that since the earth forms one pole of the system, it is clearly impossible to distinguish the leakage current from the actual working current, for the latter is also flowing direct to earth.

Even when the mains are dead and the load switched off, a satisfactory test is a matter of extreme difficulty owing to the fact that any readings obtained, for example, with an ohmmeter and generator, will in reality show the insulation of the switches, &c., rather than that of the insulated main.

As regards complying with the Home Office rules, "Meter" may be glad to know that the regulations do not insist on the fixing of an indicator in the case of an earthed system such as the one in question, so that probably a test with an ohmmeter and generator taken whenever an opportunity arises of shutting down the plant, will serve the purpose. When making this test care must be taken that all switches are open, or an earth will be indicated as mentioned by "Meter" in his letter.

Kenelm Edgcumbe.

Westminster, *February 5th*, 1906.

A Disclaimer.

It having come to our knowledge that a report is being circulated amongst the electrical trade to the effect that we undertake house-wiring contracts, thus acting in competition contrary to the interests of wiring contractors, we wish to emphatically deny this, as our business is, and always has been, entirely confined to storage battery manufacture.

It has also been stated that we are foreigners, and that our batteries come from abroad. Such a statement is quite unfounded, as all our batteries are made at our Stratford works with British material and labour, and we have not a single foreigner in our employ.

Some confusion may have arisen through a firm that makes switches and other accessories using in its title our word "Hart," but we have no connection whatever with this firm, and will thank our numerous friends and customers to address all communications to our head office and works, Stratford, London, E.

Hart Accumulator Co., Ltd.

London, E., *February 5th*, 1906.

British Customs and Electrical Exports.

If a recent shipping transaction is a common one, I am afraid the returns of our British exports as published by the Board of Trade must be totally unreliable.

Some friends of mine last month had occasion to send to Australia several hundred pounds' worth of electrical machinery. The whole of this was manufactured in Germany, but was sent to London to be transhipped. At the docks the London firm attached their name to all the cases, and no declaration of the country of origin was asked for or made.

Doubtless this shipment has gone to swell the January returns of "British Exports." May not this be a partial explanation of the fact that, although "British Exports" are increasing, want of employment is also growing?

Tariff.

February 4th, 1906.

How to Screw Conduits.

When I started this controversy in your issue of the 12th inst., I invited the opinion "of all concerned"—in particular, the opinion of responsible contractors and consultants.

Competitive conduit makers have given us their views—which I welcome, as it will serve to instruct those interested on the pros and cons of the subject, especially the latter—but I regret that we have not so far received any contributions from "independent" readers of your valued paper.

It has been suggested that the views which I expressed in my first letter are not altogether free from bias, and therefore I would like to state—and to state clearly—that, in advocating the adoption of "gas-pipe sizes and gas threads," I am advocating a change which will affect my company very seriously; it will, in fact, affect my company in very much the same way as those firms of conduit makers who have launched such violent protests against my proposals, because standard "Armorduct" conduit in the ordinary way is supplied screwed with a bastard thread. During the last year or two considerable quantities of the material have been supplied "screwed standard gas," to meet a direct and specific demand.

That a demand for conduit tubes of gas sizes and gas treads exists cannot be denied, and the fact that the majority of conduit makers who are committed to bastard sizes are careful to state in their price-lists that they are able to supply such tubes is the best proof of it.

So far as my company and its products are concerned, I will make matters quite clear, by stating that the reason why gas thread has not been definitely adopted ere now is, that it would have been necessary to increase the gauges of "Armorduct" tubes, to secure a really satisfactory result, to avoid, in other words, waste in screwing in the manufacture of the tubes; and an increase in the gauges of the tubes would have placed my company at a distinct disadvantage from a competitive point of view.

The change which I advocate "will mean an increase in the gauges of the tubes, which to-day we look upon as heavy gauge tubes."

Before I proceed I would like to deal once again with "so-called light gauge, screwed" conduit tubes, and so far as these tubes are concerned, it is a comfort to me to see that Mr. Hill is in complete agreement with my views. He admits, and admits candidly, that tubes of No. 19 and No. 20 gauge cannot be screwed, that they can be "scratched" only at the best of it, and he admits that screwed tubes of that gauge are useless.

Mr. Waterhouse "does not speak in defence of" screwed tubes of that description, and since he abandoned that brilliant idea of his of screwing open-joint tubes of No. 20

gauge, he should know, having attempted more in that direction than any of his competitors. I was surprised to hear that the Metallic Co. "still find a fairly large demand for screwed conduits of a lighter gauge," but, as they do not recommend their use, it may be assumed that they also have had opportunity to realise the impossibility of screwing this featherweight material.

In the fourth paragraph of his letter, Mr. Waterhouse, in repeating a sentence from my original letter, omits the word "gauges," and by doing so he succeeds in placing a totally different construction to that intended on my words. I draw attention to this point, because it is not quite fair to me, and because it is calculated to mislead your readers. My original letter was not intended to give offence to anyone. Mr. Waterhouse originally introduced slip joint unscrewed conduit to the electrical trade in this country; he may or may not at that time have had the intention of catering for screwed conduit work, and he may or may not have realised at the time that screwed conduit must ultimately "carry the day:" however that may be, Mr. Waterhouse accepted for his slip joint conduit the sizes which were then in use for bedstead purposes, and I find it perfectly natural that, once committed to these sizes, he should follow them for screwed conduit. And, though it is very flattering to Mr. Waterhouse to know that all his neighbours have taken their lead from him in regard to sizes, and other things, that would not justify the conclusion that the sizes which I admit are the standard for slip-joint conduit are the correct sizes for screwed conduit, and the loyalty which is now being extended to him by those firms who have followed him is, I think, the loyalty of self-preservation."

I not only admit, but maintain, that Mr. Waterhouse is responsible for the introduction of bastard sizes into screwed conduit work. I do not blame him in the least for defending these sizes, but I am strictly of the opinion that, if conduit tubes are to be standardised, a standard should be established on sizes and threads which are most likely to survive, and which possess "general utility," and, further, I am strictly of the opinion that that section of the electrical trade which is asked to pay the piper, and which has been asked to bear all the inconvenience and the cost of the muddle which exists to-day, should be given an opportunity of expressing an opinion, and I think standardisation should follow that opinion. I believe our present gauges of heavy gauge conduit (accepting a No. 16 gauge as the standard for a tube of $\frac{5}{8}$-in. diameter) do not afford sufficient protection from any point of view. I believe these gauges to be inadequate "mechanically" and inadequate from the point of view of "durability," and therefore I advocate the use of mild steel welded or solid-drawn tubes (welded tubes made from new material in preference to solid-drawn tubes made from old material) of standard gas-pipe thickness, screwed standard gas.

In America, where there exists a joint board composed of central station engineers, consulting engineers and fire insurance experts, that standard has been in existence for several years. But, if it be found that the general opinion amongst consulting engineers and contractors in this country is in favour of a somewhat lighter gauge, let us standardise on gauges sufficiently heavy as to screw standard gas comfortably. Accepting the present standard—if such a thing exists—of a $\frac{5}{8}$-in. diameter tube as No. 16 gauge, if we substitute an $\frac{11}{16}$-in. tube (*i.e.*, gas size) of No. 15 gauge, the problem has been solved and the wiring capacity of the tube would not be impaired, as the increase in size would balance the increased gauge.

Mr. Hill tells us that the thickness of gas tubes was originally settled "for the convenience of welding," and that with the appearance of seamless tubes such thicknesses have become quite unnecessary. Now, the gas trade cannot be charged with being slow in finding means and ways of meeting competition generally, and seeing that tubes of a lighter gauge would reduce the cost of gas installation work, I think the question is justified, "Why if tubes of a lighter gauge are satisfactory for gas work have they not been adopted?" The gas trade does not, I believe, look to "makeshift work" for the salvation of its problem in the same degree as do electrical engineers. Not only in this country, but all over the world, engineers continue to employ these heavy gauge tubes and with them standard gas thread (we know, of course, that for water and steam purposes tubes of a considerably heavier gauge are used, the thread being the same as in the case of gas).

Why, again, have seamless tubes not been adopted to a larger extent for gas, steam and water purposes, with the obvious advantages they possess? Is it due to the fact that gas, steam and water engineers insist upon new material where the electrical trade is frequently satisfied to accept conduit tubes manufactured from "old" material. Solid-drawn tubes are unnecessary for gas, steam and water purposes, and they are unnecessary and too costly for conduit purposes. Mr. Waterhouse accuses me of "dishing up the old trade puff" by my statement that standard "Armorduct" conduit "screwed standard gas" has been employed for a number of important installations. Now Mr. Waterhouse must know that for some considerable time past the more important Government departments, the London County Council, many leading central station engineers and the engineers of leading railway companies have established a standard for conduit tubes which asks for gas sizes and gas threads—apart from this, many consulting engineers of note and many contractors have asked for tubes of that kind. Mr. Waterhouse should remember that in dealing with the matter at issue I cannot entirely omit reference to my company—Mr. Waterhouse is not in the habit of forgetting "Simplex" in his contributions—I would like to see the personal element removed from this discussion altogether.

In giving us reason No. 1 against my proposals *he speaks of gas tube sizes as special sizes*, and that to my mind is absurd. Under reason No. 2 he states "the fact so often urged, that a contractor may have a set of gas stocks and dies is hardly worth considering, &c." Not being a contractor, and not having been asked to pay, he can afford to treat that side of the question lightly: he will agree with me that the question of screwing tackle, the cost I mean, has been the greatest stumbling block to the development of the conduit business. I submit that to-day the average wiring contractor possesses screwing tackle for various kinds of conduit of just five times the value he should ever have been asked to invest. I further submit that contractors should not be put to any further expense; and as it is to be assumed that every contractor deserving of the name has gas tools at his disposal, standardisation on the basis of my proposal would not involve anyone in any further expense; and this quite apart from the question of convenience of obtaining gas tools anywhere, and at a reasonable price. Mr. Waterhouse urges that "the state of the dies due to the rough usuage to which they are subjected in the gas trade, unfits them for use in conduit wiring." That statement I cannot accept; I am of opinion that a die or a tap which is fit for gas installation work is fit for conduit work. When it is no longer fit for the latter, it must be discarded for the former.

Reason No. 3: "The very grave risk incurred when, for the sake of convenience, cheapness, &c., rough cast-iron fittings are used in place of properly-designed malleable conduit fittings," presents no argument. It is equal to the suggestion that a man with his top-coat in hot weather is liable to perspire more violently than he would in flannels. I agree that rough cast-iron fittings are useless for conduit work (as are ordinary gas tubes), but I see no reason why "properly-designed malleable conduit fittings should be discarded because of a slight alteration in the size of the tubes employed.

"For general utility there is nothing to compare with gas sizes and gas threads," or, as a leading Lancashire contractor to whom I put the question last week put it more forcibly, when asked to express his preference, "Do I want butter on my bread?" Gas sizes and gas threads are the accepted standard for engineering work generally all over the world, and it is that standard, I think, we should make our own. Mr. Waterhouse, in his reply to my letter, states that "contractors and consultants are strongly in favour of the Simplex thread." With a view to arriving at the truth of that contention, my company last week circularised some 200 firms of consulting engineers and responsible contractors (firms not in any way selected to suit the convenience of my arguments); some 150 odd replies have been received, and they are open for inspection at my company's

head offices, to anyone seriously interested in the subject under discussion.

It is a significant fact that of the replies received, roughly 90 per cent. are in favour of the change which I advocate. The replies received represent the opinion of the leading consulting engineers and the leading contractors in the country, including the hon. president and the hon. secretary of the National Electrical Contractors' Association, and the hon. presidents of several of the local sections of that body. So it would seem after all that "there is something to explain away."

One important firm of consulting engineers have suggested to me that the question should be referred to a special Committee of the Institution of Electrical Engineers; I should not be sorry to see that course adopted, though it may be preferable to put the question on ballot to the whole wiring trade, and if Mr. Waterhouse is prepared to face that ordeal, I am prepared to stand by, and to standardise on the "Ayes" or the "Noes." Is that not a reasonable suggestion?

W. Schmahl, *Director,*
The Armorduct Manufacturing Co., Ltd.

London, E.C., *January 31st*, 1906.

So very interesting is the controversy regarding "How to Screw Conduits," now appearing in your journal, that I would like to make a few remarks from the "Contractor's" point of view, and give my reasons why I prefer gas threads.

By using gas threads, it is imperative that you secure a substantial gauge tube: equally so, you cannot use the flimsy shell-like fittings (junction-boxes, tees, &c.) as supplied by some of the manufacturers. This thread is standard throughout the country, is mechanically stronger, quicker in manipulation (both screwing and fitting up), and the same pairs of dies that screw your conduit will also be of service when connecting up to gas engine tanks, guard rails, &c. For steam, of course, it is necessary to use adjustable dies. When doing a country job, your man may have the not unknown misfortune to break his dies, or lose them, or they may be stolen. Nevertheless, he can purchase a new set at the largest local tool factors; but were he to ask for a Simplex set, how would he fare?

Reviewing one manufacturer's letter, it states: "The clumsy, heavy electrolier manufactured after the pattern of the old gas chandelier was an eyesore to everyone." Am I to believe that the electrolier was made of gas barrel or of brass tube with gas threads?

Another writer remarks that Mr. Schmahl's company, with one exception, is the only one "pushing" gas threads. I have used "gas screwed" conduit and fittings as supplied (not specially ordered) by the Insulated Tube Co., New Brotherton Tube Co., the General Electric Co., and a few others. The finest I have ever used, regarding both tube and fittings, is the Conduits and Fittings Co.'s make.

E. J. H.

As our company makes both gas tubes and conduit tubes we have read your recent correspondence respecting the screwing of conduit tubes and think that our experience may be of interest to your readers.

We have been for many years engaged in the gas tube trade and have installed here a plant of the latest type for the manufacture of gas tubes which are of necessity made to gas tube sizes and threads.

When we determined to go into the conduit trade we were naturally desirous to use our existing plant, and we, therefore, put on the market tubes and fittings of gas tube sizes and threads, but we found it impossible to get any business, and after exhaustive inquiries amongst the leading consultants and contractors engaged in the conduit trade, we found an overwhelming volume of opinion in favour of conduit sizes and threads: we, therefore, very reluctantly and at considerable cost put down a plant to enable us to supply the requirements of the conduit trade, and have never found any difficulty since.

One of your correspondents says that tubes of gas diameter allow of a greater internal clearance than conduit sizes. This, in face of the facts, is a most extraordinary statement to make. A $\frac{5}{8}$-in. heavy gauge conduit tube, measuring, of course, $\frac{5}{8}$ in. outside diameter, measures $\frac{1}{2}$ in. inside, whereas what is known as a $\frac{3}{8}$-in. gas tube, which is practically the same outside diameter, measures only $\frac{7}{16}$ in. inside.

That a better mechanical joint can be obtained with a deeper gas thread is one of those popular fallacies which a better mechanical training is gradually dispelling, although that point does not appear to have been reached by some of your correspondents.

Even in the gas-fitting trade itself the finer thread is invariably used for copper and brass, and, in fact, for everything except the iron tube itself.

We may also mention that the screwing of a gas thread is a greater strain on the tube, and costs more in work and time.

That there is a desperate effort being made by a few firms who do not want to discard their gas screwing plant to force gas sizes and threads on the market is very evident: but there is little doubt that in the long run more up-to-date methods will prevail, and that, if a standardisation ever takes place, it will be on the lines of conduit sizes and threads.

The New Brotherton Tube Co., Ltd.
Ernest White, *Managing Director.*

Wolverhampton, *February 6th*, 1906.

Overhead Equipment.

As one gets older and better educated, one tends to become less rude. It is on that account that I feel unable to reply adequately to "A Lineman."

Robert N. Tweedy.

Stourbridge, *February 3rd*, 1906.

"Lineman" has been rather a long time coming forward again, and I am afraid many readers will have forgotten the points in the argument. He still maintains that the wear at the ears is solely due to the rocking of single-truck cars, and that the cure is double bogie ones.

I pointed out that I am employed on a system where both double and single bogie cars are used on different sections, and that there is no difference in the wear at the cars. He answers that there cannot be enough wear for comparison (even though many of the ears have had to be renewed several times owing to the wear), or that the fault is in the ears themselves, or that they were not properly erected. It was impossible, of course, that they wore for the same reason that all other ears do; how could it be, when double-bogie cars ran under them?

He finds now that the greater wear on up-hill lines is due to the greater speed. "This greater speed, together with the increased rigidity and more acute pitching motion of the cars, is the cause of the excessive wear on the up-grade." I wonder, before he wrote such rubbish, did he ever watch a car grinding steadily up a steep hill—say 1 in 10? Every linesman knows that the ears on an up-grade wear quicker than those on a level or down-grade, and the steeper the hill the more wear on the up-hill ears. According to "Lineman," then, the steeper the hill the quicker the cars travel up them. Notice, too, how smoothly they glide downhill to conform with his theory.

Rigidity is another great factor in his theory. I asked him to prove his assertion that the rigidity is greater on an up-hill line than on a down-hill one; but it is beneath his dignity to reply. "When one is writing on a technical subject, one pre-supposes an average amount of intelligence in one's readers, and hence one does not explain the obvious." That, I think, is rather rich. I still humbly beg an answer; what is more, I defy "Lineman" to give a satisfactory one. If a car was running up and down the face of a cliff, the rigidity of an ear, relative to the trolley wheel, would remain the same on both journeys, provided the wire was parallel with the track, and the cars at the same distance from it, as is the case on every hill on a tramway.

"Rigidity has so much to do with the wear that even the weight of overhead fittings has an influence upon it—." How is it then that cars held by rigid pipe-hangers on short bracket arms, show no more wear than those held by 30 or

40 ft. spans, other conditions being the same? I asked him why an ear riding on the free trolley-wire, and "pitching and tossing" with it, showed the same wear as an ear 12 yds. further away, held by a rigid pipe-hanger. He answers that the ear cannot ride vertically and fouls the trolley wheels. I can assure him this particular ear does ride vertically as do several others in the same position. But I will give him the benefit of his doubts. Then how is it that round taper splicing sleeves wear away out of all proportion to the adjacent trolley wire, if placed on an up-grade? Do the cars do an extra pitch or two when they come under them?

Referring to his sketches, in fig. 3 is shown a mechanical ear with a number of waves on its under-surface. This ear has, no doubt, been erected on a down grade or level where the cars coasted under it. It shows the "bumping" style of wear explained in Mr. Tweedy's original article, only the waves are not drawn properly. The longest wave should be at the on-running end of the ear, and from there towards the other end, the waves should gradually die away. They were caused by the trolley wheel striking the point of the ear and the trolley pole set vibrating. If the points of the ear had been dressed taper to start with, the waves would not be there. From the amount of wear and comparative smoothness of the other ear shown, I would say it had been removed from an uphill wire after being arced away. "Lineman" says the waves on fig. 3 ear were caused solely by the cars rocking. Then every car, as it passed under the ear must have rocked at exactly the same rate and instant, otherwise there could be no waves, for the under-surface of the car would simply have been flattened. Does "Lineman" agree with this, or will he explain where I am wrong?

The figures showing the contact area of ears on trolley wheels are as much exaggerated as that of fig. 4, which shows the supposed contact between trolley wire and wheel.

The best way to find the actual contact area between an car and trolley wheel is to saw a thin section out of a worn trolley wheel and dress it down with a file to about $\frac{1}{32}$ in. thick, and remove the burr left by the file. Then make a similar section of an ear, and examine the contact they make with one another by holding them before a good light. Anyone who takes the trouble to try this will see at once why ears wear quickest on an up-grade.

H. Dudgeon.

Stourbridge, *February 6th*, 1906.

[In justice to "Lineman," we must explain that his article has been in our hands for a considerable time. Our correspondent has forwarded thin sections of trolley wheels and ears for inspection; we notice a discrepancy between these and the diagrams shown on p. 164. The points of conta which can be seen on these specimens indicate that the possible area of contact is insufficient to carry a heavy current without arcing.—Eds. E.R.]

Thermal Efficiencies.

In the correspondence under the heading "Thermal Efficiencies" in your issue of January 19th, we observe that an attack has been made upon steam jet forced draught by Mr. Charles Erith. This gentleman refers to this form of furnace as wasteful, and says that such steam jets cost more to work than they can save. This statement is far too general to be correct. Very much depends upon the comparison. There may be very high efficiencies secured with a good natural draught, a well-designed furnace, and careful stoking; such efficiencies, in fact, as it would be difficult to surpass with any form of mechanical draught or mechanical stoker. Also it may be at once admitted that there are very many wasteful steam jet furnaces in operation.

But a steam jet forced draught apparatus is not necessarily wasteful, and there are several at present offered which are exceedingly efficient; so much so in fact as to compare favourably in the matter of steam consumption alone with fans. We have supplied such furnaces which do not use more than 4 per cent. of the total steam raised. Such an apparatus pays interest on its cost and maintenance, and also pays for the steam used, by the saving in grate bars alone, not to speak of the saving in labour to the stoker in removing clinker from the bars. It is now well recognised that the cooling effect of the steam upon the bars is a matter of very great importance, and also that the steam which is decomposed on passing through the fire has a very beneficial effect upon the combustion in the furnace. Although we do not claim that more heat is got out of burning the steam than is required to dissociate it, yet we claim that the combustion is more perfect in the presence of the gases evolved than is the case where dry air is used. If we may take the liberty of suggesting to Mr. Erith to "pull the beam out of his own eye," we should suggest that he should devote some attention to analysing the clinkers from mechanical stokers of various types.

We have in several recent cases offered to put up furnaces with steam jet blowers for the purpose of burning these clinkers and raising therefrom sufficient steam to drive the whole of the auxiliary machinery, feed pumps, exciters and so forth in electricity stations. We expect to have our opportunity to prove that this can be done very shortly.

For the **Horsfall Destructor Co., Ltd.**
G. Watson, *Managing Director.*

Leeds, *February 5th*, 1906.

We are accustomed to hear that makers of one type of mechanical stokers state that Erith's stokers are the best for water-tube boilers, but undesirable for internally fired boilers, while makers of another type of stokers state the exact reverse, viz., that Erith's stokers are the best for internally fired, but undesirable for externally fired boilers: so we quite expected that our argument, published in your issue of January 19th, advocating moderate rates of combustion, would be challenged; but we did not expect Mr. Goodrich would controvert our view, as, in his own article in the January issue of the *Engineering Magazine*, he has very ably advocated the use of large furnaces for burning low-grade fuel, which is precisely our own contention.

Mr. Goodrich's statement that under-feeding means underworking in the case of an internally fired boiler, is quite incorrect; the rate of combustion is governed by the draught, and not by the method of feeding the fuel.

We can assure Mr. Goodrich, from the writer's own inspection of a large number of installations in Canada and the United States, that neither makers nor users of the original underfeed stokers (known as the Jones in America, and as Erith's underfeed stokers in Europe) would consider internally fired boilers using this method to be underworked. We keep a full record of the Canadian and American installations, and can show Mr. Goodrich that, for instance, at Toronto, Canada, our stokers have on internally-fired boilers given 75 per cent. more capacity than hand-fired test on the same boilers; and by increasing the draught we can get almost any desired rate of combustion, here or elsewhere; but we never look on forcing tests as of any real practical value. In the United States internally-fired boilers are very rare; but the one large American electricity station using such boilers has 84 of our stokers, fitted to three orders, in 1902, 1903 and 1904, which shows their satisfaction. We now have in hand repeat orders from H.M. Government, from the L. and N.W. Railway and from important English electricity stations for Erith's stokers for internally-fired boilers. Of course, we should not get such orders if it were true that underfeeding meant underworking.

Of course, there are unsuccessful underfeed stokers made, but we are not responsible for experimental imitations, of which there have been several, both in America and here. We do not consider that underfeeding is of any special value, unless combined with the grateless furnace and other vital features covered by the patents on our original and successful underfeed stokers.

We are entirely in accord with your leading article of January 26th, defining thermal efficiency as the percentage ratio of the thermal value of the steam *actually available* for power purposes: and we can assure Mr. Goodrich that this is our reason for preferring to use fan draught rather than steam jet blowers.

The working cost of properly applied fan draught does not exceed 1½ per cent., but we have not yet met a case where steam jet blowers for equal duty did not involve about 15 per cent., viz., ten times the working cost of fan draught. Mr. Goodrich is doubtless aware of cases where users of his own stokers have superseded their steam jets by fan draught for this reason.

Mr. Goodrich misquotes us; we did not say that "a low

boiler efficiency must be expected if slack is to be burned smokelessly." What we wrote was the exact converse, viz., that with sufficient furnace area "there is no difficulty in getting the full steaming duty out of a boiler consistently with the smokeless and efficient combustion of cheap slack coal," and we may mention that on suitable furnaces, 100 per cent. over boiler rating has been efficiently attained by some of our London clients.

A practical example of the relative efficiencies of different rates of combustion is just to hand from a large plant in the north of England, using Erith's stokers on water-tube boilers throughout.

When burning on January 30th at the rate of 22·4 lb. per sq. ft. furnace area, and evaporating 4·54 lb. per sq. ft. of heating surface, the escaping gases were 482° F., the boiler developed 20 per cent. over its rating, with 79 per cent. efficiency, and working cost, including fan, under 2½ per cent.; anyone can see this is very excellent work.

But the next day, January 31st, they burnt the same coal on the same stokers at the rate of 33·2 lb., evaporated 5·8 lb. per sq. ft. H.S., or 52 per cent. over boiler rating; the combustion in each case was excellent, showing over 13 per cent. CO_2; but at the higher duty the gases escaped at 624°, and the radiation losses were greater, so that the boiler efficiency was reduced to 68 per cent., while the working cost was somewhat increased. A superheater was used, but no economiser. The practical point is that in this case, the steaming capacity was raised 28 per cent., by increasing the combustion about 50 per cent.; we think this is a strong example in favour of moderate rates of combustion.

We are glad to notice the general approval given to our argument that for a given steaming duty, furnaces should be larger for inferior coal than for best Welsh; and we are also glad to notice the strong distinction drawn between "test results," and the commercial results which we contend are the only results worth considering.

Erith's Engineering Co., Ltd.
Charles Erith, *Director.*

London, *February 3rd*, 1906.

I quite agree with Mr. Goodrich that those who make it their business to pull to pieces the figures of others should come out into the open and not conceal their identity.

"W.G." does not appear to have seen the previous correspondence which appeared during August and September of last year on evaporative trials of Bennis plant, and it is not fair to the Electrical Review to ask them to reprint it all; I would therefore refer him to those issues.

The present controversy is an attack upon my statement in a paper read at Huddersfield that 85 per cent. efficiency is possible under the best conditions, which were defined, and I used Mr. Booth's figures as a corroboration of this statement only. I have proved my case, and as Mr. Booth's test appears to have been most carefully made, his results fully corroborate my statement.

If "W.G." knows anything of his subject, he would realise that the question which he asks in his last paragraph but one cannot be met by a general answer; everything depends upon the conditions of each place. Also what is "an ordinary heating surface ratio?"

I must apologise for taking up so much of your space with matter that is really not relevant to the controversy.

Alfred W. Bennis, M.I.Mech.E.

Bolton, *February 5th*, 1906.

It is a pleasure to see that the personal elements in this discussion are in a fair way to be removed. A good square stand-up fight between two doughty opponents is always interesting, and sometimes amusing, so long as the personalities do not become too pronounced; but one likes to see the ending happy, with mutually hearty hand-shaking; and it is pleasant to see Mr. Bennis holding out the olive branch and Mr. Booth's acceptance of it, even in a qualified manner.

Apart from that matter, however, this discussion seems to me to mark pointedly how unsatisfactory are our present methods of boiler testing—and how unreliable are the results as a basis for deduction. Of course, one knows that there are many difficulties in the way of prescribing or designing any particular method as a standard, but it does seem to me that something might be done in that direction, even if we do not reach finality at the first attempt.

Boiler tests are now generally made obligatory upon the contractor by the purchaser, and the contractor generally accepts such measuring instruments as the purchaser chooses to provide, and makes the best show he can. Results are obtained which are frequently extremely unreliable, and sometimes even ludicrous. There does not seem to me to be any reason to doubt the *bona fides* in the particular test which has given rise to this discussion. Certain results were obtained which show a certain efficiency for the boiler and stoking appliances, but what is the evidence that these results are reliable, or that in obtaining them the conditions of working were of such a nature as could be adopted in ordinary working? Very high furnace temperatures often mean blistered tubes or plates, and other deleterious effects which occasion high maintenance charges out of proportion to the advantages gained. The unreliability of water-meter readings for such purposes is almost a by-word, and often the coal, &c., weighing appliances leave much to be desired. One could enumerate vitiating elements almost *ad infinitum*.

We appoint something very near akin to a Royal Commission to draw up standards for tramrails and other things; why then should we not also appoint a committee who should draw up a standard method of boiler testing? This standard being once set would very quickly be adopted by engineers in general, and we should then probably have our furnace temperatures equalled in some way; our water measured in a tank fitted with a graduated gauge glass; our flue, &c., temperatures taken at certain definite points; our coal, &c., weighed in a certain uniform manner; and all things done with uniformity, so that the tests of different boilers would be comparable at a glance, and there need be less guess work and uncertainty as to the conditions than at present.

For my own part I regard an 80 per cent. efficiency as a thoroughly satisfactory result, and generally look askance upon anything above this; and if I had assured myself that my boilers were giving me such an efficiency, I should not attempt to adopt mechanical stokers or any other form of apparatus in the hope of improving that efficiency, although questions of smoke abatement and reduction of labour costs would probably attract my attention and lead to their adoption.

We are accustomed to hearing some people making a tirade against engineers, and especially electrical engineers, for crass ignorance about steam and steam boilers, but I am inclined to think perhaps that a large part of this ignorance is merely a simulation engendered by the existing diverse methods of testing and the incompatible results obtained; and not a little by an over-anxiety to secure data which will seem imposing to the lay minds of directors and councillors to whom they have to report upon the completion of the work. The prescription of a standard form of test would perhaps not affect this tendency, but it would give us results which would be universally comparable and largely remove the occasion for doubting their reliability when unusually good, as in this instance.

One more point: the calorific value of coal is not easy to obtain accurately, except to the practised hand, but from the commercial side of the business I feel sure that the knowledge of this value is an excellent guide in buying, and if engineers would made greater use of the chemist, expert in these matters, by having periodical tests of the heat value of their coal, they would find their action amply justified by the economies which this knowledge enabled them to effect.

E. A. Browning.

London, S.W., *February 5th*, 1906.

Leyton Tramway Construction Contract.

I have read the editorial in your last issue under the heading of "A Curious Specification," dealing with the above contract, and I quite agree that such an extraordinary procedure should be fully investigated.

Unless Mr. Lewis can give a satisfactory explanation in your columns for the exclusion of competition in this contract, from a manufacturer's point of view, I propose, with the co-operation of a number of representative manufacturers, to prosecute this business to a satisfactory issue. With this view I shall feel much obliged if you will kindly say if this is a matter that comes within the jurisdiction of the Local Government Board, or Board of Trade, or whether the ratepayers should deal with it?

Fuse Box.

[The adjudication of tenders and placing of contracts is a matter which, we believe, comes within the jurisdiction of the Local Government Board. The ratepayers, of course, are very directly concerned in the subject. A letter from the Leyton U.D.C. will be found in our "Notes" columns. —Eds. E.R.]

Electric Tramcars: Radial Trucks.

Our attention has been called to a so-called "caution" under the above heading appearing in your last issue, wherein it is stated that Messrs. Lycett & Conaty have commenced an action against us for alleged infringement of certain letters patent in respect of electrically-driven tramcars.

At the moment we can only say that we have taken the best expert opinion available, and are advised that the letters patent referred to are altogether invalid, that our radial trucks are not an infringement thereof, and that we have a complete defence to the action.

In case any action should be brought against any purchaser of our said trucks, we are prepared at our own expense to defend such action on the conduct thereof being handed over to us forthwith on the writ being issued.

Mountain & Gibson, Ltd.

Elton Fold Works, Bury,
February 6th, 1906.

Electric Lifts.

Mr. W. L. Spence has made a momentous discovery, and feeling impelled to impart it to a listening world, has very naturally addressed himself to you.

By much expenditure of the "gray matter" of which he is the fortunate possessor, and probably a like consumption of the midnight oil, he has discovered the fact that spur gearing is more efficient than a worm and wheel. May we hint, without hurting his feelings, that some of the "first-class lift builders" were previously aware of the fact, and that at least one or two of them, whose eyes were not quite shut, have noticed here and there a crane constructed with spur gearing.

But your correspondent, by one agile intellectual effort, leaps straight to the conclusion that consequently lifts also should be constructed with spur gear.

Now the British "first-class lift builder," recognising that in lifts life is always at stake, has always placed safety as the first consideration and economical efficiency second. The result has been that for a long time past accidents to lifts by way of failure of the machine itself have been almost unknown.

Who among us does not instinctively walk round rather than under a swinging crane-load; and, on the other hand, who hesitates to step into a lift and permit his beloved self to constitute a portion of the actual load?

The contrast in instinctive confidence is born of the records of the two types of machines—and yet Mr. Spence advocates the cutting away of one of the factors which make for safety in the lift.

For, be it remembered, that with a high efficiency gear, control depends absolutely on the brake, a notoriously unreliable and variable adjunct. In a worm gear lift, when current is withdrawn, the loaded machine struggles to stop, brake or no brake, whereas in the spur gear machine it struggles to run away with increasing speed, and opposes the brake with all its energy.

Electric brakes have been proposed in this connection, but are they not already used on most tramcars? Surely we have heard of runaway cars on steep hills, and at the inquests have been told how the electric brakes failed to act.

First-class lift builders have a deeply-rooted antipathy to Coroners' Inquests, a weakness resulting, no doubt, from a lack of "gray matter."

Mr. Spence is enamoured of mechanical efficiency, but this is not the be all and end all of lift building.

"Will you persuade your wife to sing?"

"With pleasure, if you will persuade her to stop."

It is just so with electric lifts. Can Mr. Spence persuade one of his machines which he modestly dubs "rational," to stop, and that in a rational manner? A user wants it not merely to stop, but to do so at the floors.

The high-efficiency machine, descending with a load at, say, 200 f.p.m., and required to stop, demands a very powerful brake to bring it to rest, and may, nevertheless, run on for a yard or more. In the nature of things, the brake power is a constant quantity. Next time, the lift is ascending with a load, and on withdrawal of current would stop in a few inches of its own accord, but the same powerful brake has to be applied, and the combined effect of brake and load will arrest it with such a shock as to be unbearable.

But with the contemned 37½ per cent. efficiency lift the gear will of itself stop the machine, both ways, on withdrawal of current, and the brake becomes merely an assistant to regulate the stopping distance. These are merely two of the principal objections.

Now, what is there to compensate them? Mr. Spence says 50 per cent. saving of current, but 40 per cent. would be nearer the mark with good machines. What does it amount to? We have shown in some published results that the average current consumed per annum in several hundred lifts of all sizes and all over the country costs £8 7s. A high-efficiency design would reduce this to £4 7s. Who would knowingly exchange a machine well under control for one much less so for the sake of £4 per annum if his "gray matter" were of average amount? Finally, the high-efficiency machine is much easier to design, and far cheaper to manufacture, than one in which the mechanical efficiency shall be kept above 45 per cent., and yet never exceed 50 per cent.—a problem which the leading makers are daily solving with all sizes of machines and all weights of cages. The only reason which prevents responsible firms from offering these cheaper machines is their objection to treating human freight as mere merchandise, and to building lifts on the same rough-and-ready lines as cranes.

The subject is a many-sided one; Mr. Spence has approached it correctly enough on one side, but he will need to expend much more "gray matter" before he gets all round it.

A. Smith & Stevens.

London, *February 5th*, 1906.

Mr. W. L. Spence's imagination is almost as wonderful as his figures. First of all, in presuming that I am associated with Messrs. Richmond & Co., he is—well, presuming. It is a bitter blow to my self-esteem that my connection with Faraday House is not known to him. Secondly, what the Americans call "gray matter" was called "gray matter" by English physiologists centuries before Mr. Spence or I ever had any. Thirdly, we will, if you please, omit any reference to my shamelessness; this is as likely to be an accompaniment of unconscious virtue as of hardened vice.

If Mr. Spence will read my original article carefully, he will find that I did refer to the steel guides as the reason for the improvement of the efficiency of the lift, taking the motor efficiencies as identical.

Mr. Spence is putting a severe strain upon my credulity in his statement of a lift having a 70 per cent. efficiency—take the motor at 75 per cent.: his gearing, a double gearing, mind you, must therefore have an efficiency of 93 per cent. Good Heavens!

The lifts I tested could not move even if the brakes failed and there was no current on, thanks to the gearing. The lift he refers to might, in such circumstances, very easily travel either up or down on its own account, with a steadily increasing momentum. This, of course, introduces some excitement into the monotony of a lift attendant's life, but to the ordinary passenger, safety has its attractions, and makers ought to sacrifice something to get it.

I like Mr. Spence's suggested guarantee of *in*efficiency as the standard, it is so original, analogous, indeed, to giving a

man a character which recites only his faults and has no mention of his virtues. But, with lifts, as with men, we must know what they *can* do, not what they *cannot*.

Percy Good.

Faraday House, *February 6th*, 1906.

London's Street Lighting.

I have no doubt that Londoners, who take a pride in their City, will welcome the proposal of the City of London Electric Lighting Co. to light several streets at its own expense. If it should bring about the removal of those wretched incandescent gas lamps, which at present disgrace Fleet Street and other streets, it will be a move in the right direction.

It is strange that London should be so far behind provincial towns as regards street lighting. The ugly gas lamps recently erected in the City are only to be found in side streets in many provincial cities.

In Leeds gas lighting is dying out fast, and electric light seems to be everywhere; not only all the central thoroughfares, but many side streets, are now bright with electric light, and in no town in England is there a square as brilliantly lighted as Victoria Square, Leeds.

The gas lighting papers still continue to find fault with electric light, and will do so as long as people are foolish enough to believe their misleading reports.

An Old Reader.

Electric Power in a Graving Dock.

I notice in your "Scottish Notes" on page 175 of last week's issue, that you state that Messrs. Barclay, Curle and Co. were the first people to use current for repair work in Govan Graving Dock. This, however, is a mistake, as Messrs. Fairfield Shipbuilding and Engineering Co. applied to us for current nearly three years ago, in May, 1903, and we then laid a cable down to the dock, and they used current in the repairing of ss. *Kinfauns Castle*.

Since then current has been used by one or two firms on small repair jobs.

T. C. Parsons,
Burgh Electrical Engineer.

Govan, *February 5th*, 1906.

Referring to your note on page 103 of the 19th ult., also page 175 of 2nd inst., regarding electric power in Govan graving dock, may I be allowed to state that both Messrs. Watson & Co., Glasgow, and the former correspondent are in error, an installation of this kind having been fitted up in the same docks under my supervision as far back as May 18th, 1903. This plant was run continuously night and day until July 13th, 1903, for alterations to the hull of the *Kinfauns Castle*. A number of electric drills, fans, grindstones, circular saw and lamps were in use during that period.

At the same time, viz., June 25th to July 15th, 1903, current was supplied from our generator to light up H.M.S. *Terrible* in the next dock.

A motor was laid down at the dock side, which was supplied with current at 500 volts from the Govan Corporation electricity works. This was belted to a dynamo giving current at 115 volts for the whole of the temporary work in the ships mentioned above.

I can vouch for this being the first demand on the above Corporation for an installation of this kind at the Govan docks, as the cables were laid in from the Govan Road to the motor at that date.

Prior to that date, viz., August, 1901, we laid down a gas-driven set for supplying current during repairs to the *Kildonan Castle* in dry dock. The dynamo was belt driven from a Stockport gas engine; it was a 50-KW. dynamo, giving 450 amperes at 115 volts. Drilling machines, saw, emery grinders, and a large number of lamps were in use throughout the ship and dock.

Another instance of power driving took place in July, 1900, when a large repair was carried out on the *Empress Queen*. Current in this case was received from the ship's dynamo, and electric drills were used to cut out the damaged portion of the ship's hull. The aforementioned repairs were carried out by the Fairfield Shipbuilding Co., thus showing their claim to be pioneers of this class of work in Govan Docks.

Glendale.

LEGAL.

An Electrical Engineer's Bankruptcy.

Before Mr. Justice Bigham and Mr. Justice Darling, sitting as a Divisional Court to hear bankruptcy appeals on Monday, the appeal in *re* A. J. Harris, *ex parte* the trustee, *v.* A. J. Harris & Co., Ltd., and H. Myers and W. J. Fawcett, which was an appeal from a decision of his Honour, Judge Bompas, was heard.

Mr. Mellor said the appeal was from an order of the learned County Court judge made on November 29th last. The order was refusing a motion asking for a declaration that a transfer by the debtor to a limited company of his business was a fraudulent transfer. What the appellant (the trustee) said was that on the eve of his bankruptcy, without consulting his creditors, the debtor, an electrical engineer, converted his business into a limited liability company, and practically said to his creditors that they must take debentures, whether they liked it or not, in respect of the debts due to them. Such a transaction, he submitted, could not stand, because, under the Bankruptcy Act, where there was an assignment of substantially the whole of a bankrupt's assets in such a way as necessarily to defeat or delay his creditors in respect of their legal remedies, it was fraudulent under Sec. 43. The facts in this case were that Harris, who had carried on his business as an electrical engineer and dealer in electrical fittings since 1902, in 1903 borrowed from a Mr. Wm. Mitchell a sum of £500 at 5 per cent. interest per annum. There was an arrangement whereby Mr. Mitchell's son became his apprentice for three years, with a view to becoming a partner. The interest fell into arrears in 1905, and Harris promised Mr. Mitchell that he would not dispose of his business or assets without letting him know. In July, 1905, however, the firm of A. J. Harris & Co., Ltd., was formed with a nominal capital of £2,000 in £1 shares, and an agreement was entered into for the sale of the debtor's assets to the company. The debtor, himself, was allotted fully-paid shares and debentures, and the consideration was that the company was to discharge the debts of the debtor. As soon as Mr. Mitchell heard of that he issued a writ. Bankruptcy proceedings followed, and on August 18th a receiving order was made. He submitted that the debtor's intention had been to do what had resulted in his property being taken out of the reach of his creditors, unless they chose to accept debentures for £750 held by him.

Mr. Justice Bigham, after some argument, said it seemed to him to come to this, that the debentures were not worth much.

Mr. Waugh and Mr. Newell followed for the respondents, and after considerable further argument, the appeal was dismissed.

York Company's Affairs.

Mr. Justice Warrington on Tuesday delivered his reserved judgment on a summons taken out by the Halifax Joint Stock Banking Co., Ltd., asking for a declaration that Herbert Watkins, who had been appointed receiver and manager of the British Power Traction and Lighting Co., Ltd., of York, in a debenture-holder's action was not entitled to be indemnified out of the assets of the company in respect of certain debts and liabilities incurred by him in carrying on the business of the defendant company, and, further, whether Watkins's creditors were to be paid out of the assets. Alternatively, plaintiffs asked the Court to settle the priority of the various creditors.

His Lordship granted a declaration that Watkins was entitled to be indemnified only against those debts and liabilities over and above an overdraft of £3,000 on Barclay's Banking Co., as to which he could satisfy the Court that he was justified in incurring them without first obtaining the leave of the Court. The part of the summons referring to priorities might stand over until the Registrar had dealt with the several claims.

Andrew *v.* National Electric Construction Co., Ltd.

At the Court of Session at Edinburgh on 24th ult. the trial was concluded of the action in which Matilda Renton, or Andrew, sued the defendant company for £2,000 damages for the death of her husband, William Andrew, retired inspector of police, who was killed on June 5th last at the car terminus, Levenhall, by a car which had jumped the points and crushed him against the wall.

The jury returned a verdict for the pursuer, and assessed the damages at £650.

The Manchester Tramways and Goods Traffic.

Mr. Justice Farwell has this week delivered his judgment in this important case in which Messrs. Sutton & Co., carriers, sought an injunction against the Manchester Corporation in connection with their recently instituted goods collection carriage and delivery system. The exceptional pressure upon our space this week compels us to hold over the full report until next week. In brief, his Lordship said he proposed to make a declaration that the defendants were not entitled to expend any part of the city fund or the receipts of their tramway undertaking, or the proceeds of any city rate, or any other moneys of the defendants or of the city for the purpose of establishing, or maintaining, or carrying on the business of carriers except as part of and in connection with their tramway undertaking and in respect of articles carried along all or part of the tramways for the time being belonging or on lease to the Corporation, or on which they had power to place or run carriages, and to grant an injunction on similar terms.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"Hack" writes:—"Would you please inform me whether, in pricing out stock for the purpose of drawing up balance-sheet, the price should be taken exactly at the figure paid irrespective of the market value of the material having gone up or down. Such a point as this may easily show a profit, whereas in reality there might be a loss, if bad bargains had been made, and the materials priced at the sum originally paid. Surely it would be fair if the market values at time of stock-taking are taken as the basis?"

*** This question is one which hardly comes within the definition of a legal query. Much would depend upon the particular trade; but it is presumed that if you want to estimate the value of a business as a going concern on any particular date, it is necessary to take the value of the stock at that date. Some portions of the stock may have advanced in price, others may have depreciated. It is the custom when making out a balance-sheet to write off something for depreciation.

"Garage" writes:—"A man having a supply of electrical energy into his house from the front, builds a motor garage in his back yard, facing another street, in which the *same* supply company have mains.

"There is no communication between the yard and the garage, and to enter the latter it is necessary to go into the street.

"Is the consumer entitled to an independent supply to the garage? If the garage were let to a tenant, the company would have no objection to putting in another service. Are they entitled to distinguish between consumers in this way?"

*** Speaking without the advantage of having seen any decision upon the point, it is anticipated that a supply company could not be compelled to connect up with two sets of mains. If the garage were let to a tenant, that tenant would have the right to call upon the company to give him a supply, and it appears to be quite allowable for them to say to "Garage," "If you let to another tenant we shall lay a new service main." But it is conceived that they are also fairly entitled to say to him, "The garage and your house are on the same premises, and we do not think it worth while to incur the expense of making an additional connection."

"Borough Electrical Engineer" writes:—"The Corporation of A are supplying electricity within their borough with powers conferred by a B. of T. provisional order. The Corporation of B are also supplying under a provisional order in their borough.

"Can A supply a railway company with electrical energy within their borough, and the railway company use it, or some of it, on their property, within the borough of B?"

*** The question put has never been decided in relation to electricity, but it has been decided in relation to gas in a way which will probably not be satisfactory to "Borough Electrical Engineer." By the Metropolis Gas Act, 1860, Sec. 6, the limits of each gas company then supplying the metropolis were defined, and, in the result, each company enjoyed a practical monopoly in its own district. One of these companies, at the request of a railway company, placed a meter on a part of a railway station lying within the company's limits, and through it supplied gas to other parts of the premises situated outside the company's limits, and within the limits of another company. The Court of Appeal held this to be lawful, on the ground that the sale and delivery of the gas took place at the meter; but the House of Lords reversed this decision, holding that the gas was supplied where it was consumed, and therefore that the company were transgressing their authorised limits. Gas Light and Coke Co. *v.* South Metropolitan Gas Co., 62 L. T., 126; 5 T. L. R., 731. This principle would, it is conceived, be applied to electricity.

BUSINESS NOTES.

Parliamentary.—*The London and Brighton Motor Way Bill.*—This Bill should have come before the Examiners of Standing Order proofs on Thursday last week (February 1st), but when the Bill was called it was found that no appearance had been made. The Bill was accordingly marked "dead." The scheme was for the incorporation of a company with a capital of £2,250,000, for the construction of a motor way from London to Brighton, and it was proposed to employ authorised electricity undertakers to supply current. The Bill also took power to supply electricity to persons using electrically propelled vehicles on the motor way.

Book Notices.—*Les Procédés de Commande à Distance au moyen de l'Electricité.* By R. Frilley. Paris: Gauthier-Villars. 1906 Price 3.50 fr.—The extended and rapidly extending use of electrical apparatus for distant control, which is so much more convenient and elastic than the means formerly in vogue, has led the author to write this little book, in which he deals with the methods of control adopted, without discussing their actual applications. He classifies the various systems according as they drive direct, or employ relays, rotating fields, Wheatstone bridge devices, induction coil sparks, escapements, and Hertzian waves. The electromotor, of course, figures prominently in the direct-driving category, and the author first discusses the characteristic features of its various forms, afterwards explaining systems of direct control. The other systems are then separately dealt with, diagrams being given in each case, with a concise description. About 36 systems are included, covering a wide range of applications, from electric cranes to range finders.

The Practical Electrician's Pocket-Book and Diary. Edited by H. T. Crewe. London: S. Rentell & Co. 1906. Price 1s. net.—This little annual has now attained the age of eight years, and appears likely to keep on growing in years and usefulness. Various additions to its contents have been made, certain chapters have been re-written and the others brought up to date, and thus that perpetual youth in spite of years is maintained which is indispensable to this class of publication. Besides general information regarding electrical, steam and gas plant, systems of wiring, lamps and instruments, a number of useful tables are given, including a directory of British towns equipped with electricity supply, with the pressure, frequency, &c., and the usual forms for estimates. The book is well printed on good paper, and opens like any other book—a point in its favour.

L'Année Electrique, Electrothérapique et Radiographique. By Dr. F. de Courmelles. Paris: Ch. Béranger. 1906. Price 3 fr. 50. This annual review summarises the progress made in all branches of electrical science in 1905, giving abstracts of many articles which have appeared in the technical journals, and references to others. The work, however, is not a mere collection of abstracts, editorial comment being freely interspersed. As might be expected, electro-medical matters occupy a very large proportion of the space, and having regard to the excellent work that has been and is being done by French investigators in this direction, a concise summary of their results such as this ought to be of great service to British medical men.

Some Notes on the Home Office Rules for the Use of Electricity in Mines. By W. C. Mountain. Newcastle-on-Tyne: The Author, Sun Buildings. 2s. 6d.—A great deal of misconception seems to exist in the minds of mining engineers and colliery owners as to these rules. The author has had this fact in view, and it is to be hoped that those to whom the pamphlet appeals will obtain a copy, as it gives a simple explanation as to how these rules can be carried out without undue expense. The rules are printed separately in their paragraph form in red, and immediately following, in black, the author gives a full and lucid explanation of each. Besides the rules, a large amount of useful information, such as power tables, cable-carrying capacities, losses in pipes, both for air and water, &c., which is of value to mining engineers, is also included. The pamphlet is printed on art paper and is profusely illustrated.

"Modern Turbine Practice and Water-Power Plants." By John W. Thurso. London: Arch. Constable & Co. 16s. net.

Science Abstracts. Index to Parts A and B, for Vol. VIII., 1905. London: E. & F. N. Spon. 1s. 6d. each net.

Science Abstracts. Parts A and B, January 29th, 1906, Vol. IX., Part 1. London: E. & F. N. Spon. 1s. 6d. each net.

"The Seven Follies of Science." By J. Phin. London: Arch. Constable & Co. 5s. net.

"Radiography and the X-Rays." By S. R. Bottone. Second edition. London: Whittaker & Co. 3s. 6d. net.

"Central Station Electricity Supply." By A. Gay and C. H. Yeaman. Second edition. London: Whittaker & Co. 10s. 6d. net.

Messrs. Archibald Constable & Co., Ltd., announce a new work by Prof. Ernest Rutherford, Professor of Physics at the McGill University, Montreal, Canada, on "Radio-Active Transformations," which will be published early in the spring.

London.—Gas.—Mr. Corbet Woodall, presiding at the meeting of the Gas Light and Coke Co., remarked that the revenue was £36,000 less than the sum necessary to pay the dividend recommended, and in the last three half-years the deficiency amounted to £92,000. He remarked that it was due to elements in the ordinary course of trading. Suction gas and cheap electric power supply were alluded to, and "it was a matter of congratulation that they were holding their own in the struggle." Naturally, mention was made of the action of the City Corporation in re-introducing gas lighting in one or two streets. This, together with the introduction of gas lighting at Broad Street and Victoria Stations, appears to afford an inexhaustible source from which our lighting competitors may derive consolation. The company has a system of keeping consumers' burners in order at a charge of 9d. per quarter, and 149,000 burners are now under inspection.

Map of Metropolitan Railways and Tramways.—A new map has just been brought out by Mr. Edward Stanford, of 12, 13 and 14, Long Acre, London, W.C., showing the metropolitan railways, tramways, and miscellaneous improvements. Amongst other interesting additions are the works, routes, and mains, &c., proposed in the Electric Power Supply Bills to come before Parliament this year. The map is issued in two sheets, as in 1905, on a scale of 3 in. to the mile, each sheet measuring 30 in. × 40 in., and costs 10s. 6d. It forms an excellent work of reference for all who are engaged or interested in metropolitan projects, being clearly printed in several colours, and naming all but the very smallest streets and landmarks.

German Imports and Exports of Electrical Machinery.—A large increase took place last year in the exportation of electrical machinery from Germany, the shipments reaching a total of 8,362 tons as compared with 7,179 tons in the preceding year. On the other hand, a falling off took place in the imports of foreign electrical machinery into Germany—from 693 tons in 1904 to only 676 tons last year.

New Rolling Stock for the Metropolitan District Railway.—An order has been placed with the Brush Electrical Engineering Co., of Loughborough, for 40 steel trailer coaches for the Metropolitan District Railway. The cars are to be of similar design to those at present in service on this line, but steel is to be used instead of the non-inflammable timber of which the existing rolling stock is constructed.

The Edwards Air Pump.—The following is a list of some electrical stations to which the Edwards patent air pump has been recently fitted. It will be observed that in a number of cases the pumps are for turbine installations:—

Beckenham; Birmingham; Bombay (three sets of three-throw pumps); Buenos Ayres (four sets of three-throw pumps); Burton-on-Trent; Bury; Cleveland and Durham Central Electric Power Distribution Co., Ltd. (four sets of three-throw pumps for turbines); Devonport; Fulham; Glasgow Corporation (three sets of three-throw pumps, for 3,000-kw. turbines); Islington; Leyton; Melbourne; Metropolitan Electric Power Supply Co.; Middlesbrough; Newcastle and District Electric Lighting Co., Ltd. (turbine plant); Newcastle-upon-Tyne Electric Supply Co., Ltd. (two sets of three-throw pumps for turbines); Newport; Norwich (turbine plant); Rangoon (three sets of three-throw pumps); Scottish Central Electric Power Co., Ltd. (turbine plant); Shoreditch (turbine plant); South Metropolitan Electric Supply Co., Ltd.; South Wales Electric Power Co., Ltd.; Wimbledon (turbine plant).

Cable Theft.—A former employé of the Underground Electric Railways Co. of London, in his attempt to steal cable had sawn through the cable on a drum at Gloucester Road, and walked through the tunnel to the Brompton Station; here he over-balanced himself on a plank and fell 40 ft., receiving such injuries that his life was at first despaired of. He was charged with the theft at Westminster last week, and was sentenced to 21 days in the prison infirmary. It was stated for the company that in some instances drums of cables had been entirely spoilt by thieves.

The Metric System in the U.S.A.—The Decimal Association has issued a leaflet pointing out that in December last a Bill was introduced into Congress, providing for the compulsory adoption of the metric weights and measures in all departments of the Government of the United States on July 1st, 1908. A number of quotations are given from the *New York Herald*, which is strongly supporting the proposal. The question is under consideration by the committee on coinage, weights and measures.

Electromobiles in Hungary.—A company has just been formed in Buda-Pesth with a capital of 500,000 kronen to introduce a service of electrical motor broughams and cabs in the city.

An Unhealthy Accumulator Factory. — At the Thames Court last week the London Electrical Syndicate, Ltd., of Abbott's Road, Poplar, were summoned for having their workshop in such a condition that the process of manufacturing electric accumulators cannot be carried on without danger to health. Mr. Bellhouse, Inspector of Factories, who prosecuted on behalf of the Home Office, said the proceedings were taken under Sec. 18 of the Factory and Workshops Act, and he asked for an order to prevent the further manufacture of electric accumulators. From the report in the *Daily Telegraph* we gather that Dr. T. Morrison Legge, Medical Inspector of Factories, attached to the Home Office, said he visited the workshop on the 23rd ult. The manufacture of electric accumulators had been scheduled by the Secretary of State as a dangerous trade, and at the works mentioned the regulations in question had not been conformed with. Those regulations dealt with the manipulation of lead compounds, to guard against the danger of lead-poisoning; and the work at defendants' manufactory could not be carried on without danger to health, unless the regulations were complied with. The mixing of red lead and litharge paste had been carried on without an exhaust fan to carry away the dust, consequently the workmen had to inhale it. Witness found a workman who had suffered from lead-poisoning, which had been contracted owing to the way the work had been carried on. In addition to the fan he had mentioned, the bench at which the mixing was done should be covered with sheet-lead and the floor concreted, so as to be capable of being washed down every day. He recommended the Court to make an order that the manufacture of electric accumulators should not be carried on until the improvements had been effected. Mr. Mead made the order asked for, and allowed 25s. costs.

The Aron Meter.—Notice recently appeared in the *London Gazette* signifying the Board of Trade approval of the Aron motor meter deposited by the Aron Electricity Meter, Ltd., of Union Street, Borough, S.E.

Sentence.—At Manchester Assizes on January 31st, John M'Cambridge was sentenced to 12 months' hard labour for defrauding the British Westinghouse Co., Ltd., to the extent of £60. Accused had been employed by the company at a weekly wage of £2 5s., and he obtained the money by making out false expenses sheets for fictitious journeys.

The "Simplex" Floor Opener.—In our notice of this serviceable little device on p. 197 of our last issue, we should have added after "Patrick's patent" the words "applied for." The address of Mr. F. Patrick is 14, Oxford Street, Leeds, not Glasgow as stated by us.

Annual Dinner.—The members of the Hull Corporation electric lighting department held their annual gathering on January 31st. Councillor Hanger presided, and Mr. H. Bell (chief electrical engineer) was present.

Brush Contracts.—The following new contracts have lately been booked by the Brush Electrical Engineering Co.:—

For the South Metropolitan Electric Tramways and Lighting Co., Ltd., 500-kw. steam turbo-alternator and condensing plant.
For the Cadzow Coal Co., electrical coal cutter.
For Torquay (per National Electric Construction Co.), 16 double-deck car bodies.
For the Diesel Engine Co., 100-kw. dynamo.

Trade Prospects in Mexico.—In the course of an interesting article in the *Financial News* of February 2nd, on "British Manufacturers Miss Opportunities in Mexico," Mr. Percy F. Martin, F.R.G.S., makes the following remarks, which call for attention at the hands of British electrical manufacturers and engineers:—"One corporation here—the Mexican Light and Power Co., Ltd., which is Canadian, and therefore British—has elected to place an extensive order for electrical machinery with an American firm, although, probably, had British firms at home put themselves to the same trouble to secure the contract, by sending out a representative and studying the situation, as did the American company, it might, at least, have succeeded in part. The General Electric Co., of New York, have not only secured this great contract, but they have likewise furnished all the costly electrical plant, machinery, rails and cars for the fine electrical tramway service of Mexico City. I am given to understand that a keen amount of competition did take place between American, German, and one or two British firms, the Germans being, as usual, particularly anxious to secure the order. The Germans and the Americans are now sharing between them the several big orders which are being given out for railway material and electrical installations, there being an enormous amount of activity here among the various constructional trades. The Tramway Co. of Mexico City is one of the few British enterprises to be found here, being the offspring of Messrs. Wernher, Beit & Co.'s investments in this country. With a few more capitalists of their vast resources, coupled with the splendid practical enterprise of Messrs. S. Pearson & Son, Ltd., of Victoria Street, Westminster, who have done more to popularise British capital than any firm I have ever heard of, the deplorable state of affairs to which I have referred would speedily be at an end, and a period of prosperity for British trade in Mexico would be inaugurated which would be as profitable to our languishing industries at home as it would prove acceptable to the friendly and estimable Government of Mexico itself. Let us hope that even at this, the eleventh, hour British manufacturers will turn their eyes to Mexico, remembering that they are not, as yet, too late; for 'there is always room to be found at the top.'"

Dissolutions and Liquidations.—Webster Electrical Engineering Co., Ltd.—This company is winding-up voluntarily, with Mr. W. M. Gray, of District Bank Chambers, Bradford, as liquidator.

T. C. Stuart & Co., cycle, motor and electrical engineers, 129, High Street, Croydon.—Messrs. A. E. Lamkin and T. C. Stuart have dissolved partnership.

A. Gilbert & Co., glassware and electrical sundries merchants, 82, Turnmill Street, London.—Messrs. A. Burrows, W. C. Gooderson and O. Morschhauser have dissolved partnership. The two former partners will continue the business and attend to debts.

Telescriptor Syndicate, Ltd., 34, Victoria Street, S.W.—February 21st is the last day for receiving proofs for intended dividend. Liquidator, Mr. Edwin Waterhouse, 3, Fredericks Place, Old Jewry, E.C.

Haslam & Richardson, electric lamp agents and dealers, 10, Summers Street, Nottingham.—Messrs. S. Haslam and A. S. Richardson have dissolved partnership.

Shoolbred & Connell, electrical engineers, 231, Strand, W.C., and at Luton.—Messrs. H. G. Shoolbred and F. R. Connell have dissolved partnership. Mr. Shoolbred will attend to debts.

A. E. & H. Robinson & Co., gas, oil and air engine manufacturers, 78, Great Bridgewater Street, Manchester.—Messrs. H. Robinson and G. Procter have dissolved partnership. Mr. Procter will attend to debts, and continue the business.

Trade Announcements.—Mr. A. Eckstein, M.I.E.E., late managing director of the General Electric Co., Ltd., who established himself in business in October last at 7, Market Street, Manchester, has now taken into partnership Mr. A. C. Heap, and in future the firm will be known as "Eckstein, Heap & Co.," manufacturing electrical engineers and suppliers of all kinds of electrical accessories. The works address is Waverley Mills, St. Simon Street, Salford, and the showrooms and warehouse are at 5, Chapel Walks, Cross Street, Manchester. Messrs. Eckstein, Heap & Co. are laying themselves out as specialists in the design and manufacture of all kinds of high and low-tension switchgear, and will shortly place on the market complete sets of apparatus suitable for central stations, collieries, works, mills and private installations. Some references to the partners and staff of the new firm appear in "Our Personal Column" to-day.

The St. Helens Cable Co., Ltd., have transferred their

premises at Newcastle-on-Tyne from Pudding Chare to 33, Clayton Street West, and the cable and rubber departments will be under the charge of Mr. Morley and Mr. Bond respectively. They have also closed their Edinburgh branch, and transferred it, together with the Glasgow branch, to new premises at 191, Howard Street; the cable and rubber departments will be under the charge of Mr. Cowie and Mr. Sinclair respectively.

The Sunbeam Lamp Co., Ltd., who have hitherto been represented by an agent at Birmingham, have now opened a depôt at 18, Burlington Chambers, New Street, Birmingham.

The receiver and liquidator of the Perfecta Seamless Steel Tube Co., Ltd., informs us that he has disposed of the business of this company to the Perfecta Seamless Steel Tube and Conduit Co., Ltd. All future orders will be given out by the new company, who are continuing the business at the same address as before.

Railway Construction in Canada.—According to a recent report by the United States Consul at Chatham, Ontario, quoted by the *Times*, the scheme of railway construction in Canada, which will require from three to five years for its completion, is expected to reach a total of 7,344 miles. The work projected, together with that included in electric railway projects, will necessitate about 1,000,000 tons of 80-lb. rails in the next four years, and in addition 300,000 to 400,000 tons of iron and steel for car and locomotive building, switches, trestles and bridges. It is further estimated that in the present year Canadian railways will require over 100,000 tons of bridge material for renewing and strenghtening bridges, the Grand Trunk Railway alone needing for this purpose 30,000 tons.

For Canada.—A firm of manufacturers' agents in Montreal desire to be placed in communication with a British house manufacturing electric cotton threads for electrical purposes, as they are in a position to open up considerable trade in this direction. For further information apply at the Canadian Trade Inquiry Office, 73, Basinghall Street, E.C.

Bankruptcy Proceedings.—A. J. Harris.—At Bradford County Court on January 30th, Albert John Harris, electrical engineer, of Bradford, applied to Judge Bomras, K.C., for his discharge from bankruptcy. The debtor failed in 1905, and the proceedings were reported in these columns on September 1st, 1905. On behalf of the trustee, Mr. J. H. Stamford opposed the application on the ground that a County Court action had been raised in which it was alleged that a fraudulent transfer of debtor's business had been made by the debtor. In that action, his Honour had held that there had been no fraud, but as that decision was to be appealed against, an adjournment was asked for, pending the hearing of the appeal. The Judge said the question with him was whether, his judgment having been challenged, it was fair for him to take an opportunity in the interval of assuming that his judgment was right. If an adjournment meant delay for any length of time, he would not hesitate to act on that assumption, but he thought it would only be reasonable to grant an adjournment for a fortnight.

LIGHTING AND POWER NOTES.

Beaconsfield.—The U.D.C. has refused to give consent to the application of the Uxbridge and District Electric Supply Co., Ltd., for a prov. order to supply energy in the district.

Birmingham.—The City Council has adopted the report of its Electric Supply Committee as to the letting out of motors on hire; also as to presenting a petition against the Shropshire, Worcestershire and Staffordshire Power Bill.

Brierley Hill.—The U.D.C. has decided to inquire of the Midland Electric Corporation for Power Distribution whether it is willing to purchase the Council's E.L. order.

In connection with the Shropshire, &c., Power Bill the Council is communicating with neighbouring councils on the subject, and in regard to the same Bill the Shropshire C.C. has decided to oppose it, to secure certain protective clauses.

Bromley.—The R.D.C. has resolved to petition against the Kent and the L.C.C. Electric Power Bills in respect of overhead wires and the veto of route for underground mains.

Continental Notes.—Italy.—A concession has been applied for to erect a water-power plant on the River Macra at Sottano, for E.L. and power purposes.

La Societa per l'Illuminazione et Distribuzione Energia Elettrica intends to erect a power station at Valleggio.

It is proposed to put down a water-power plant at Valle-Castellana (Teramo) for lighting and power purposes.

A company has just been formed at Bologna, with a capital of £140,000, to be known as the Società Bolognese di Elettricità, to establish an electricity works in the town.

Austria.—A company has recently been formed in Genoa, Italy, with the object of establishing large steel works in Dalmatia. It is proposed to utilise the water-power of the River Almissa in connection with the undertaking, in which Messrs. Ganz & Co. are interested.

Roumania.—The municipal authorities of Giurgevo are about to invite tenders for the electric lighting of the town, which is estimated to cost nearly £40,000. The municipality of Pitesci has decided to accept offers for the electric lighting of the town.

Spain.—The Sociedad Hidro-Electrica de Trubia has received a concession to erect a plant on the River Nalon.

France.—According to a Continental contemporary the Société des Acieries de la Marine has recently acquired rights to build a power plant at the Bellegarde Falls. It is proposed to erect works for the production of steel, &c.

Crediton.—The U.D.C. has decided to call a special meeting to pass resolutions as follows:—To petition the B. of T. to revoke the prov. order granted to Messrs Christie on the ground "that it might create a monopoly," and as to the Bill of the Local Lighting and Power Co., "that the Council take steps to oppose it."

Cumberland.—Messrs. Wylie & Lochead, of Glasgow, contractors for the installation of the E.L. at the Asylum, have informed the County Council that they had made an unfortunate mistake in their calculations, having charged for ordinary instead of insulated tubing. The difference in cost would be about £1,000, and they asked the Committee to reconsider their contract. The Committee has replied that they have no funds out of which they can make any payment in excess of the contract.

Derby.—The E.L. Committee has recommended the T.C. to adopt the following scale of charges for energy for power for all-day use as from April 1st, 1906:—Up to 5,000 units per quarter, 1¼d. per unit; over 5,000, and under 10,000, 1½d.; over 10,000, 1d.

Edinburgh.—The question of what provision should be made for meeting the renewals of plant, &c., in the electricity undertaking came before the T.C. recently, and it was agreed to remit to Prof. Kennedy and Mr. Newington to prepare a report on the present condition of the plant, for guidance in the matter.

Electricity in Cotton Mills.—The Fine Cotton Spinners' Combine and Doublers' Association has written to the Bolton Corporation as to a supply of energy for cotton mill driving purposes, and the matter is to be proceeded with.

Greenock.—The T.C. has agreed upon the erection of a refuse destructor to be worked in combination with the electricity department.

Lancashire.—On the 30th ult. a conference of representatives of Lancashire U.D.C.'s was held in Manchester to consider the Lancashire E.P. Bill and the South Lancashire Tramways Bill, 1906. The Lancashire Electric Power Co. is seeking extended powers to enable it to supply power to individual consumers within the area of any authority having an E.L. order, with the consent of the authority, but this consent is to be deemed unreasonably withheld and consequently to be dispensed with in all cases where the local authority is unable or unwilling to offer terms at least as favourable as those offered by the company. It was decided to instruct the Parliamentary representatives of the various councils to vote against the second reading of the Bill. An executive committee was appointed to act with representatives from each of the county and non-county boroughs. The Bill is meeting with local opposition, on the ground that it strikes at the principle of municipal monopoly. The opposition, however, is not unanimous. There are many who believe that the Power Co.'s scheme, if carried out, will lead to an industrial revival in the area of supply, but, on the other hand, various municipal bodies in South Lancashire are said to regard the Bill with alarm.

Lancaster.—The T.C. has agreed to supply electrical energy to the L.N.W.R. at 1½d. per unit for power purposes, for their wagon repairing works. The company will take a minimum of about 50,000 units per annum.

Lincoln.—The Electricity Works Committee has recommended the T.C. to apply to the L.G.B. for a loan of £13,000 for extensions at the electricity works.

Liverpool.—Last year the Electric Supply Department contributed £16,934 towards the rates, and the estimated amount this year is placed at £19,740.

London.—Hackney.—The B.C. Electric Lighting Committee has decided to revise the existing scale of charges for energy which, except so far as they relate to factory power, have been in use for over a year. The Gas Co. is making strenuous efforts to promote its business, and it is necessary, says the committee, for the municipality to take active steps in the matter. The tariff for private lighting is now 7d. and 1d. per unit, on the maximum demand system, or an optional flat rate for old consumers of 4d., and it has been decided to reduce the initial amount to 6d. and to give all consumers the option of a flat rate of 3½d. The new scale of charges for power giving satisfaction; the committee considers it would be well to extend it to cover heating purposes, and has agreed to make an optional flat rate of 1½d. per unit for power and heat, and to allow power consumers to use up to 20 per cent. of the energy supplied for lighting purposes. A reduction to 3d. per unit is to be made for lighting and power to places of worship. The foregoing charges are to come into operation on April 1st next. Electric lighting by means of 7-ampere arc lamps is to be substituted for gas in nine streets and roads. The annual cost of the new lighting will be

£1,248, as against £676 at present paid. The Finance Committee has pointed out that clause 35 of the L.C.C. Bill goes beyond any provisions which have up to the present time been inserted in private Acts of this nature, as it would enable the County Council to put in motion the machinery of the Board of Trade to secure a reduction of the prices charged to ordinary consumers by borough councils. The object of the clause is, no doubt, to compel borough councils who are generating electricity at a higher cost than they could obtain it for from the C.C., either to reduce their charges and supply consumers at a loss or to take a bulk supply from the C.C. The committee recommends that unless the clause is amended or modified a petition be presented against it.

The Tower.—On February 3rd several streets were plunged into darkness owing to a breakdown in the gas supply. This necessitated the drafting of extra police into the district.

Marylebone.—The B.C. has decided to seek the sanction of the L.C.C. to a further loan of £151,162 to complete the electricity undertaking.

Greenwich.—The B.C. has issued a circular to the various Metropolitan Borough Councils regarding the breaking up of streets, and suggests that this should be checked by the limitation of the powers of companies. The Greenwich B.C. hopes that the other London municipalities will consider the matter and mutually support each other on the question.

Southwark.—The Works Committee of the B.C. has reported that experiments have been carried out with numerous lamps in the lighting of the side streets at present lit by electricity. It has concluded that the 1-amp. Nernst lamp fitted in a Windsor lantern is the best. The illuminating power is equal to 120 candles. The committee is in favour of their adoption for the whole of the side streets at present lighted by electricity, and has decided to convert them at an estimated cost of £300. The cost of maintainance will be about the same as at present, as the E.L. Committee agrees, owing to the improved position of the undertaking, to supply the extra energy required without any additional charge. There are now 41,481 (equivalent 8-c.p.) lamps connected up, 9,749 of these representing power.

Leyton.—The U.D.C. has decided that consumers guaranteeing a minimum payment of £200 per quarter for energy shall have the option of a flat rate of 3½d. per unit.

Longton.—The T.C. on February 1st decided to adopt an alternative flat rate of 6d. per unit, less 5 per cent. discount.

Manchester.—The action brought by Mr. J. Emmott Barlow against the Corporation on account of vibration from the Dickinson Street generating station appears now to be settled. The terms have been reported by the Corporation Committee as follows:—Mr. Barlow to be recouped all expenditure to which he has been or may be put, by reason of the vibration occasioned to his warehouse either before or during the course of the action, together with interest at the rate of 5 per cent. from the respective times of payment by him. Until the purchase money for the property is actually received by Mr. Barlow, the existing payment of £1,000 a year to continue to be paid by the Corporation. The value of the warehouse and the injury sustained in respect of Mr. Barlow's adjoining property are for the purposes of the arbitration to be taken to be its value at March, 1899, a date anterior to the first complaint of vibration. The purchase money and compensation to be assessed on the basis of a compulsory sale by Mr. Barlow to the Corporation, the effect of which would be to entitle him to an addition of 10 per cent. upon the purchase money. Mr. Barlow to receive the sum of £1,000 as damages on the action being terminated. His costs as between solicitor and client of and incident to the agreement for reference, the arbitration, and the vesting of the property in the Corporation, and also all disbursements made by him for that purpose to be paid by the Corporation.—*Manchester Guardian.*

Mexico.—The *Board of Trade Journal* says that a contract has been entered into for an appropriation of water from the River Trinidad de Jaltepec for power purposes.

New Hunstanton.—Last Friday's *London Gazette* contains notice of the revocation of the 1901 electric lighting order.

Reigate.—The T.C. has received from the L.G.B. sanction to raise a loan of £4,000 for E.L. purposes.

South Africa.—East London.—During a severe thunderstorm on the 10th ult., lightning struck the overhead mains, and considerably damaged one of the generators at the power station.

Pretoria.—A person was sentenced to two months' imprisonment recently, for making connections to his service lead on the supply authority's side of the meter.

Cape Town.—The Cape Peninsular Lighting Co., who supply the suburbs with electric light and power, has recently inaugurated a system of deferred payments for wiring and fitting installations. It is expected that this new departure will result in an increased number of consumers. The rate per unit still, however, remains at a high figure, about 1s. 6d. net, as against the Cape Town Corporation charge of about 10d. net. The wiring of installations will be let out to contractors, but the company will provide fittings.

South America.—Argentine.—It is reported that the German Electric Light Co. has offered to the Santa Fé municipality to take over the E.L. station and to electrify one of the tramlines.

Chili.—The public electric lighting was inaugurated in Chacabuco on the 1st ult.

Stafford.—At a recent T.C. meeting it was suggested that about £6,300 will have to be expended on extensions to the electric lighting undertaking to meet the increasing demand.

Tamworth.—The Corporation has decided to negotiate with the Shropshire and Worcestershire E.P. Co. for the transfer of its prov. order to the company, subject to the approval of the B. of T. and the payment by the company of all costs.

Tonbridge.—A L.G.B. inquiry was held on January 30th into the application of the U.D.C. for a loan of £2,000 for E.L. purposes. There was no objection.

Whitehaven.—A special meeting of the T.C. was held on January 31st to consider the Cumberland Electricity and Power Gas Bill. It was explained that the promoters would be prepared to supply energy within the Council's area at ¾d. per unit, against 2d. charged by the Corporation. The Council decided to petition against the Bill.

TRAMWAY AND RAILWAY NOTES.

Argentine.—The La Plata Government has granted a concession to Messrs. Gandulfo & Co. for the working of an electric tram line from Barracas Bridge to La Plata and the docks, passing through Quilmes, Florencio Varela and Villa Elisa.

Bradford.—The elective auditor, Mr. J. Lund, in a letter to the *Yorkshire Observer* of the 5th inst., points out the necessity of providing an adequate reserve for renewal of track, before utilising the surplus revenue for relieving the rates. As things are at present, the renewals fund is less than 5 per cent. of the capital expended, and Mr. Lund asks whether in a few years it will not be necessary to levy a rate in aid of the tramways.

Canada.—United States Consul Ifft, at Chatham, Ontario, reports that an electric line, backed by American capital, is to be constructed in the spring between Chatham (Ont.) and Windsor. This will be on the line to Detroit, Mich., and will link up a considerable system of trolley lines on both sides of the frontier.

Croydon.—Now that the Croydon Corporation has definitely decided not to renew the lease of the B.E.T. Co., the Penge extension has been pushed forward, and it is expected that the first car will run from South Norwood to Penge in a few days. The question is now being asked: What will happen when the Penge extension on one side of the Croydon system and the Mitcham system on the other is isolated by the Corporation taking over the control next May? There should certainly be a good case for running powers. The company controlling the Penge line is to be known as the South Metropolitan Tramways Co.

Douglas.—The T.C. has considered the question of converting to electrical working the horse and cable tramways, and of introducing electric lighting along the tramway routes, and has empowered the Tramway Committee to engage expert advice on the matter.

Dudley.—The B.E.T. Co. filed a declaration in the Chancery Division to the effect that the company were not bound to sell to the Corporation certain tramways (No. 5, Dudley, Netherton and Cradley Heath section) within the borough; the case was heard on Friday last before Mr. Justice Kekewich, when the company's application failed. The arbitration respecting the original agreement is to commence on the 27th inst. at the B. of T. Meanwhile the Electrical Committee of the Corporation recommends the T.C. not to pass in its present form the proposals for reconstructing and electrically equipping the tramways on the Tipton Road.

Folkestone.—The T.C. on February 1st decided to give the consent of the Council to the application of the National Electric Construction Co., Ltd., for powers to construct tramways. The stipulations attached to the consent include the following:—The company is to construct and equip the tramways at its own expense at a price to be agreed upon; the Council is to have the option of purchasing the undertaking at the end of 7 to 14 years on payment of capital expenditure plus goodwill of 25 and 15 per cent. respectively, and at the end of 21, 28, 35, 42, 46 and 50 years on payment of capital expenditure only; the company to pay to the Corporation, on signing the agreement, £16,200 towards the cost of street widenings, and the cost of the Council's tramway order. The company is to carry out other street widenings, and no advertisements are to be allowed on the cars.

Glasgow.—The Tramway Committee of the Glasgow T.C. and the District Committee of Upper Renfrewshire have come to a deadlock with regard to the proposed extension of the tramway to Clarkston. The Tramway Committee has decided to delay consideration of the proposal until approached by the local authority of the district interested, and the District Committee has adhered to its resolution that the County Council, of which it is a Committee, being by the General Tramway statute appointed to ac

judicially in connection with all applications to lay tramways on country roads, it would not be expedient or proper to hamper it in the discharge of its statutory duty by petitioning the City Corporation in the matter.

The annual social gathering of the employés of the Corporation Tramways Department was held last Friday night. The Lord Provost, Mr. William Bilsland, presided, and in the course of his remarks said that during the past ten years they had written off £1,000,000 on depreciation and sinking fund. Last year their revenue was £765,000. They were carrying 200 million passengers per annum. The mileage of single-track was 152 miles. The tota staff was now 4,600, having more than doubled in ten years. The benevolent association in connection with the department had 3,300 members, and some £2,400 had been distributed last year in aliment.

Hastings.—The T.C. having refused to consent to tramways on the overhead system being constructed along the sea front, the Tramways Co. have informed the Council that they have decided to adopt the G.B. surface contact system.

Huddersfield.—A conciliation board to settle differences between the Tramways Committee and their employés is likely to be established in Huddersfield. There will be an independent president, to whom appeal will be made if the Board fails to arrive at a settlement of any point in dispute.

Hythe.—An action has been commenced against the Hythe Corporation in respect of the Council's consent to the National Electric Co.'s scheme of tramways. The plaintiffs' claim is for an injunction restraining the Council from giving consent to any Bill authorising the laying down of a tramway within the borough, which may not be in accordance with the recommendation made by the General Purposes Committee of the Council on August 5th, 1905.

Liverpool.—On Thursday last week Lieut.-Col. von Donop, R.E., conducted an inquiry on behalf of the B. of T. into the recent tramway accident, when the driver and other witnesses gave evidence. No explanation was offered for the failure of the car to keep the rails.

During the past year the Liverpool Corporation Electric Tramways had a traffic income of £550,000. The working expenses—including £43,200 for maintenance and renewal of cars and fittings, £95,600 for electrical energy, £121,100 for salaries and wages, £38,000 for maintenance and renewals of lines and electrical equipment, £23,300 for rates and taxes, £11,000 for compensation and law charges—totalled £379,378. Out of the balance of £177,677 a sum of £2,000 was contributed to the city fund, and £25,319 in aid of the general rate. For interest on loans £54,000 was required; for sinking fund £55,300; and £50,600 was placed to the reserve, renewal and depreciation account, which stands now at £214,398.

From the tramways last year the rates received £27,109. The estimated municipal income from this source for this year is £25,320.

Experiments were made last week-end in running a specially constructed coach from Southport, on the Lancashire and Yorkshire Railway Co.'s electrified line, to Dingle, on the Liverpool Overhead Electric Railway. Passengers from Southport to any of the stations on the Overhead Railway, which communicates directly with the Liverpool docks, have at present to change from the one line to the other at Seaforth. Should the result of the experiments justify the "through" service, more special coaches will be built. This proposed development indicates the satisfaction of the Lancashire and Yorkshire Railway directors with the two years' working of the electrified Liverpool-Southport section of their railway.

Llandudno.—A special meeting of the U.D.C. was held on Saturday, to consider a communication from the firm who have arranged to take over and complete the Llandudno and Colwyn Bay Electric Railway. The proceedings were conducted in private, but the *Liverpool Daily Courier* is informed that, having heard the letter from Messrs. Bruce Peebles & Co., it was found that an agreement had practically been arrived at, except with reference to the question of Sunday running. The terms were:—(1) That Llandudno Council would agree that the tenure should be for 42 years before the Council should exercise their right of purchasing the line; (2) that Llandudno Council should reduce the price of electrical energy; and (3) that the Council would permit the Sunday service to be run. The Council agreed to the first two conditions. As to the third, it was resolved that the question be deferred until the line had been in actual operation for 12 months, at the expiration of which time the promoters should be given the right to demand a poll of the ratepayers, whose decision is to be final.

London.—Metropolitan District Railway.—A L. & N.W. train ran off the line at the Mansion House at 11 p.m. on Saturday last, and much inconvenience was caused.

A breakdown also took place at Mark Lane Station on Monday evening.

Paddington.—The B.C. on Tuesday, after a stormy debate, resolved to petition against the L.C.C. (Tramways and Improvement) Bill for running a line along the Edgware Road.

L.C.C.—The suggestion that the delay in opening the tramway service under Kingsway is due to failure of the contractors to deliver the rolling stock in time has been vigorously repudiated by the latter, who state that they have not received instructions to start the construction of the cars.

New York City.—The Rapid Transit Commission, which supervises the electric traction of Greater New York, has discussed the recent combination of the subway, elevated and surface systems, and individual members express the view that the financiers will ultimately have to come to terms with the city, for it would not be a very difficult matter for the city to find the capital to construct new subways now under consideration. The traction representatives have given out a statement relative to the financial side of the amalgamation, and announce the formation of a new company with a capital of £30,000,000 to hold the shares and stock of the combined lines. On December 24th, during some rock-blasting operations on the East River Tunnel, a portion of the ground at the Battery fell in, and for a time endangered the elevated railroad structure in the vicinity. Similar blasting operations in 34th Street are also said to have endangered the foundations of the Waldorf-Astoria Hotel.

North-Eastern Railway.—An accident, happily unattended with injury to life or limb, occurred on the 4th inst. upon the electrified section of the North-Eastern Railway at 10.20 p.m., between Tynemouth and Cullercoats. The bogie of the third coach left the rails and came into contact with the live rail, which was considerably damaged. The traffic had to be worked by a single line for several hours until the damaged rail was repaired; but little inconvenience was caused, as by 7 a.m. next day the ordinary traffic was resumed.

Railway Companies and Electricity. — At the meeting of the L.B. & S.C. Railway last week, Lord Cottesloe, the chairman, in referring to the subject of electrification, said that they had hoped that the work would have been commenced some time during the course of last year. "Various difficulties had, however, been met with, which it had taken a good deal of time and lengthened negotiations to surmount. The delay had brought with it some advantages, however. In the first place, Victoria Station, though progressing favourably, was still in the transition stage, and, if the electrification of the South London lines had been taken in hand a year ago, it would certainly have been impossible to provide the electrical equipment in that station or on the lines leading to it from Grosvenor Road Bridge. A year's delay had, therefore, brought nearer the time when it would be possible to fix the necessary apparatus for electric working in that station. A second reason why the delay had been advantageous was that the system fixed upon had had a longer trial and had been improved in several details, with the result that the board were now so satisfied with its reliability that, instead of equipping only a short section of the South London line as a preliminary experiment, they felt justified in dealing with the whole of that line right through from London Bridge to Victoria. The company was now in active negotiation for a contract with the General Electric Co., of Berlin, and in the arrangements with that company it was proposed to require that, with the single exception of the motors for the first set of eight trains, the whole of the plant should be of British manufacture."

At the half-yearly meeting of the London, Tilbury and Southend Railway Co., Mr. Arthur L. Stride, who presided, said that the cost of traction in respect of their own electric trains between Campbell Road Junction and East Ham had been considerably in excess of the cost of steam traction. He knew, however, as a member of the board of the District Co., that the present rate of expenditure for operating the electric trains over that system was not normal. The men were new to the work, and a considerable waste of energy had taken place. Every week now a great improvement took place, both in reference to the cost of running the trains and in smoothness of working. The District Co. were supplying them with energy for their electric train service to East Ham. It had not yet been definitely settled what they would have to pay for that energy, but a sum had been included in the mileage and demurrage account which, he felt confident, would be ample for the purpose. So far as locomotive power proper was concerned, they had run 160,000 additional miles at no greater cost, although, it was true, there had been a small saving in the price of coal.

In their report for the half-year, the directors of the North-Eastern Railway say that they are also glad to inform the proprietors that their further experience of electric traction on the suburban lines in the Newcastle district has been entirely favourable, both from the practical and from the financial point of view.

St. Leonards.—The Tramways Co. has submitted a scheme to the T.C. for the utilisation of an underground system for a line along the front.

Salford. — The local branch of the Tramway Employés' Union is claiming for all men in the service of the Salford Tramways Committee, increased pay. The men demand that their wages shall be brought up to the rate paid in Manchester, which they say is the standard of the district. The demand is being considered by the Committee.

A proposal is on foot for the introduction of experimental ½d. car fares for three months, from April 1st, on the Swinton, Pendlebury and Peel Green routes.

Southend.—The T.C. recently held a special meeting to consider the proposed extensions of the electric tramways. The necessary majorities were, however, not forthcoming, and the proposals have been dropped.

Sunderland.—At a meeting of the Tramways Committee of the Corporation on the 1st inst., the estimate for the year ending March next was submitted. This showed that the total income for the year was expected to reach £67,345, and that the total expenditure would be £64,845, which would leave £2,500 as a contribution

to the relief of the rates. For the previous year the income was £65,026, but of this sum nothing was contributed to the borough funds.

Surrey.— The South Metropolitan Tramways Co. has commenced the construction of new lines which will connect Croydon and Mitcham with Beddington, Wallington and Carshalton on one route, and Sutton on another. The same company is now constructing an electric tramway connecting the Croydon Corporation system with Norwood, Anerley and Penge, the aggregate distance of the new routes being about 10 miles.

Whitehaven.— The T.C. has resolved to petition against the West Cumberland Electric Tramways Bill, under which the promoters seek, among other things, power to supply the railway companies and the Harbour Commissioners with energy for power and lighting.

Worthing.—The T.C. has decided not to negotiate at present with private firms for the construction and working of the tramways under the Council's order.

TELEGRAPH AND TELEPHONE NOTES.

Argentina.—The Direccion de Correos y Telegraphos has been authorised to expend a sum of nearly 10,000 pesos on the construction of a branch telegraph line to unite the town of Camilo Aldao with the National Telegraph system.

A meeting of the shareholders of the Co-operative Telephone Co., of Rosario, has been held, and according to the *Review of the River Plate*, it has been resolved to form the company to carry out the work; the capital is to be 500,000 pesos.

The telegraph system between Buenos Ayres and Mendoza is to be increased by the addition of two new lines. New lines are also to be erected between Buenos Ayres and Bahia Blanca. The order for the wire has been sent to the Argentine Minister in London.

Dutch Cable.—The Netherland Indies Administration has corrected the length of the cable from Celebes to Borneo from 628·680 kilometres to 625·680 kilometres.

New Cables.—In a review of 1905, the *Journal Télégraphique* enumerates schemes for laying cables, the carrying out of which will be completed in 1906, and succeeding years. Among these is a submarine cable to be laid by the United States Government to the Isthmus of Panama, one by the Mexican Telegraph Co. between Galveston and Coatzacoalcos, and others by the Central and South American Telegraph Co. between Chorillos Iquique and Valparaiso.

The North-Eastern Siberia Co. is to open up a landline system between the United States, Siberia, China and Europe, and a landline is to be erected across the Sahara to connect Algeria and Southern Nigeria.

New German Cable Steamer.—To replace the *Von Podbielski*, recently sold to the Dutch Government and renamed *Telegraaf*, the Norddeutsche Seekabelwerke ordered early last year a new vessel from the celebrated firm, F. Schichau, of Danzig, and on October 21st this latest addition to the World's Telegraph Fleet was launched under the name *Grossherzog von Oldenburg*. Her class is the highest of the German Lloyd. The principal dimensions are as follows: Length between perpendiculars, 292 ft.; breadth, 41 ft. 4 in.; depth, 28 ft. Displacement, 4,650 tons; dead weight carrying capacity, 2,260 tons. Total capacity of cable tanks, 30,019 cb. ft. Her bunkers hold 590 tons of coal, and her speed fully loaded is 11½ knots. She has twin screws, of course. A departure from the usual spar deck type has been made by the provision of a long working forecastle, which will, no doubt, greatly add to the comfort of her crew, besides providing increased working facilities. Everything about the ship is of the highest quality; the cable machinery was made in Danzig, and embodies all the latest improvements. The ship, taken as a whole, should be exceptionally suitable both for the laying of new cables and for the carrying out of repairs in the North Sea, for which she has been especially designed.

New Telegraph Offices.—The opening of a new telegraph office at Kransneus, in German South-West Africa, is officially announced by the German Administration. Kransneus is situated about 35 kilometres south of Windhuk. The African Direct Telegraph Co. have also opened an office at Akure, Northern Nigeria. The new line between Laos and Siam is open for traffic.

New Telegraphic Transmitter.—Mr. John Gell, a member of the Institution of Electrical Engineers, and formerly (for 32 years) connected with the New Zealand Telegraph Department, has invented a perforator and transmitter for automatic telegraphy which, it is claimed, marks a distinct advance The special point of the invention is that one depression of the key forms the perforations necessary to represent any given letter in the alphabet and also provides the space between it and the next letter to follow. The keyboard is similar to that of a typewriter, and the mechanical efficiency of the instrument is such that it will respond to the speed of the fastest typist. Mr. Gell has also designed a simple and efficient form of transmitter.

Post Office Contracts and Wages.—The Postmaster-General has consented to receive a deputation from the Parliamentary Committee of the Trade Union Congress in regard to the placing of contracts with firms whose conditions of working and rates of wages paid are contrary to the letter and spirit of the fair wages resolution of the House of Commons of February, 1891.

The River Thames.—On Monday, at the meeting of the Thames Conservators, it was reported that, in November last, the National Telephone Co., Ltd., had been called upon by the Board to remove 26 overhead wires, placed by them without permission over the river at Staines. The company had stated that they were making arrangements for crossing the river by means of a cable, but the chief inspector sent information that the wires had not yet been removed. It was resolved to serve a notice requiring the wires to be removed within seven days. Permission was given, under protective conditions, to the Postmaster-General to stretch four additional wires over the river at Laleham. The Post Office authorities are to be informed, however, that in future cables under the river should be employed.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	..
Dominica-Martinique	May 7, 1902	..
St. Lucia-Martinique	May 7, 1902	..
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	..
Cayenne-Pinheiro	Aug. 18, 1902	..
Port Arthur-Chifu (Closed)	Mar. 7, 1904	..
Jamaica-Colon	Jan. 5, 1905	..
Cadiz-Tenerif	July 20, 1905	..
Tarifa-Tangier	Jan. 18, 1904	..
Puerto Plata-Martinique	Oct. 30, 1905	..
St. Thomas-St. Kitts	Dec. 28, 1905	..
Bolama-Bessao	Jan. 19, 1906	..
Jamaica-Puerto Rico	Feb. 1, 1906	..
Cable route to U.S. Columbia, *via* Galveston	Feb. 1, 1906	..
Landlines.		
Puerto-Barrios	Aug. 28, 1902	..
Communication with Brazil *via* Galveston	July 18, 1905	..
Communication with Alaska *via* Seattle	Jan. 17, 1906	..

Telegraphs and Telephones in Sweden, 1903.—The telegraphic system of this country at the end of 1903 comprised 9,571·85 kilometres of line and 29,023·2 of wire. Of these 2,047·2 were only used for telegraphic purposes, and 7,524·65 for telegraphic and telephonic purposes. During the year 76,385 fr. were spent in the purchase of new poles and impregnating them with antiseptic solutions. Offices numbered 2,343, there being one for every 2,304 of the inhabitants of the kingdom. There were about 4,500 employés engaged in the telegraph and telephone service. Of telegrams there were 2,638,022 paid for and 2,885,625 free, the latter being service and meteorological telegrams. Of 12,652,113 words, 3,552,258 are claimed by Germany; 2,830,133 by Great Britain; 1,919,478 by Norway; 1,851,953 by Denmark; 615,995 by France; and 485,092 by Finland. 7,089 telegrams were undelivered owing to insufficiency of address, and there were 143 claims for refund of charges, 45 of which were rejected,

Telephones.—There were 1,466 stations and 1,873 call offices, and 177,050,898 messages were dealt with, of which Stockholm claimed 25,364,100, Goteborg 20,673,800, and Gefle 9,684,800. Revenue from the two systems amounted to 9,228,682 fr. (about £369,147), while the expenses were 8,809,630 fr. (about £352,385), leaving a balance of 419,052 fr. (about £16,762), of which about £10,000 has been taken to reserve fund.

Wireless Telegraphy.—The United States Navy Board has purchased, for £3,000, ten sets of the wireless telegraph apparatus invented by Mr. Walter M. Massie, of Providence, R.I. These will be used experimentally at the Washington Navy Yard and at various naval stations on the Pacific Coast. So far the United States Government has not committed itself definitely to any particular mode of space telegraphy.

The Peruvian Government has granted to a German company the right to establish a wireless telegraph system in the basin of the Amazon.

A *Standard* New York dispatch gives notice of a "most important development in connection with wireless telegraphy just become known." It is said that the Associated Press, the largest customer of cable companies, is undertaking a series of experiments which, if successful, may entirely revolutionise the trans-Atlantic cable business. The message states:—"For several days wireless messages under a new system have been exchanged between Machrihanish, at the south-western end of the Mull of Kintore, and Plymouth Rock, Massachusetts." Experiments are being conducted by the National Electric Signalling Co. of America. To ensure a thorough test of the system, it is said the representative of the Associated Press at Machrihanish transmits his wireless messages in cipher unknown to his colleague on the other side of the Atlantic, and that Mr. Stone, the general manager of the Associated Press, says the experiments so far give promise of a satisfactory result.

Three masts, 225 ft. high, are being erected by the De Forest Wireless Telegraph Syndicate at Cambridge, Oxford, and at Shoeburyness to demonstrate the advantages of the De Forest system.

It is rumoured that German agents have intercepted and appropriated wireless telegrams dispatched from Gibraltar, Land's End, and other stations by British naval authorities, by means of a system of wireless telegraphy installed at Corunna. In some cases, it is stated, telegrams have been tapped at Corunna whilst being dispatched from British men-of-war.

THE CHESTERFIELD ELECTRICITY AND TRAMWAY UNDERTAKINGS.

The town of Chesterfield has long claimed the passing interest of the traveller by reason of its celebrated spire—

Mr. R. L. Acland, A.M.I.E.E.,
Borough Electrical Engineer and Tramways Manager.

celebrated because of its twisted structure and the many twisted stories which hang thereby — which remains suspiciously suggestive of the old-time jerry-builder's art.

But apart from this, the town, with its 30,000 inhabitants, has every claim to consideration as a busy centre of the mining and iron industry, with a thriving population and every incentive to be up-to-date in things municipal.

As might be expected in such a locality, the necessity for an electricity supply was early recognised, and the Corporation obtained a provisional order to that end in 1894. The Corporation took no action in the matter, however, for some years, and this delayed definite progress until the year

Fig. 1.—The Chesterfield Electricity Works.

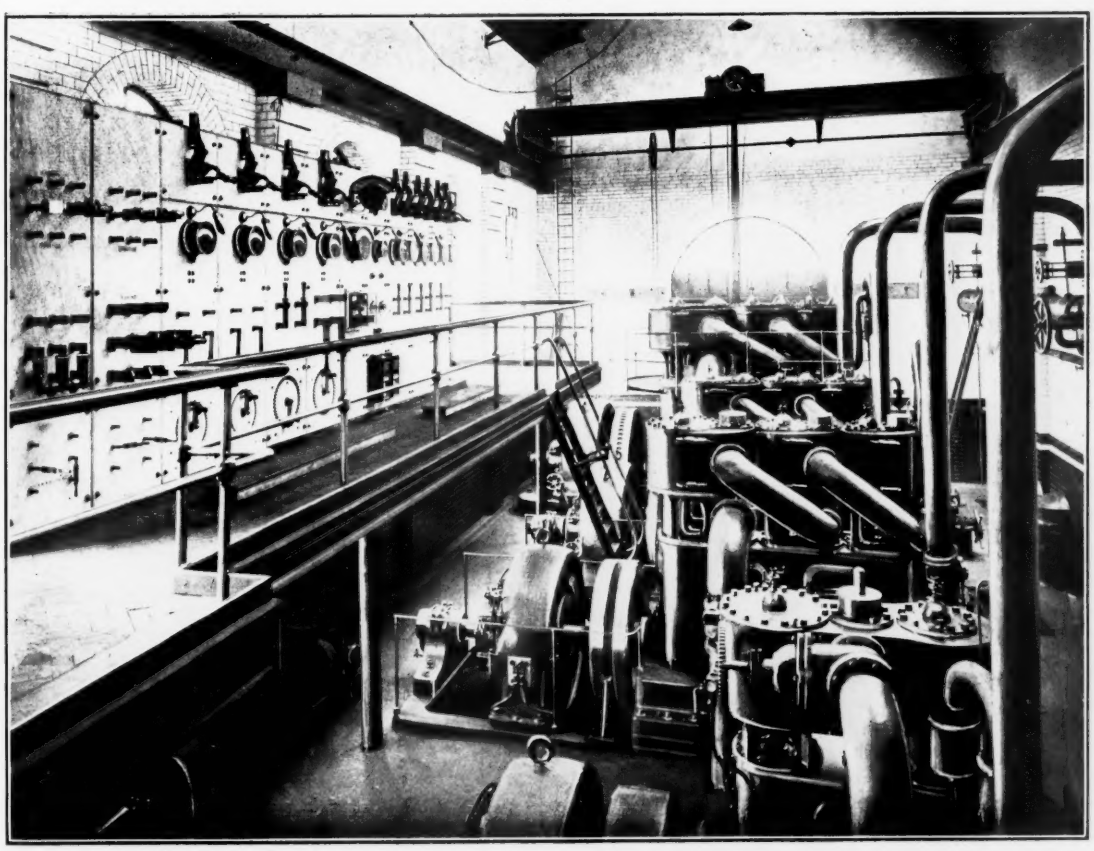


Fig. 2.—View of the Engine Room from the Switchboard Gallery.

1900, when a general scheme for a 200-KW. plant was submitted by the British Westinghouse Co.

In the same year, Mr. R. L. Acland was appointed borough

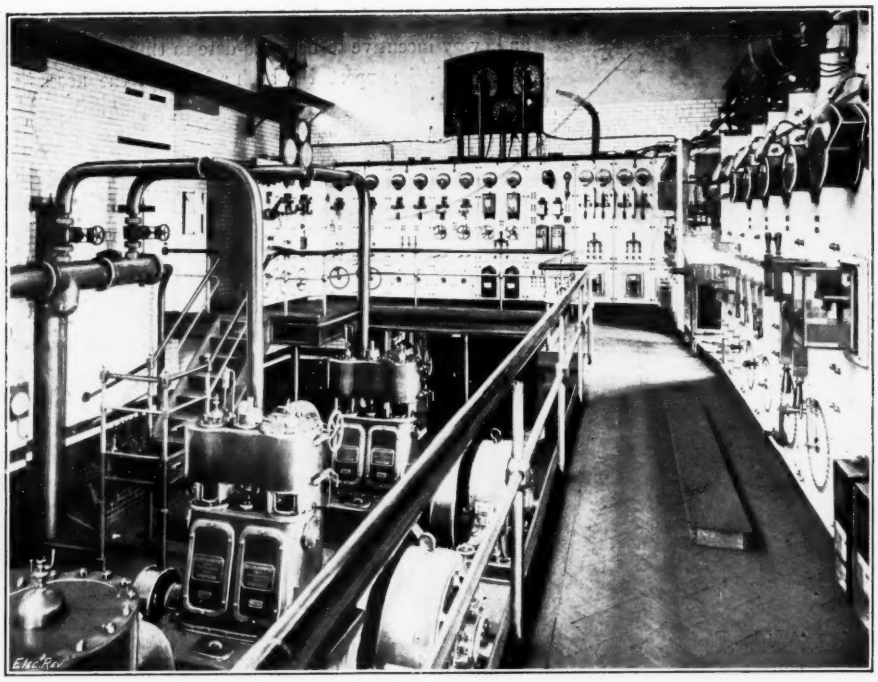


Fig. 3.—View of the Lighting and Traction Switchboards

electrical and consulting engineer to the Corporation to advise on and carry out the scheme, which, under his guidance, has with successive extensions reached its present capacity of 1,000 KW.

The Corporation having been empowered to reconstruct and extend the then existing horse tramways, purchased from the Chesterfield Tramways Co. for some £2,000, the transfer taking place in January, 1898. Subsequently, in 1903, Mr. Acland was entrusted with the design and supervision of the electric tramways, the latter being supplied with energy from the original generating station.

The generating station, car depôt and offices are all located on a site adjoining the Chatsworth Road, where an ample supply of water for condensing and feed purposes and facilities for obtaining coal existed.

The station itself (fig. 1) is a compact little building, containing engine and boiler houses, together with a battery room and offices; a basement under the engine room contains the condensing plant, cables, &c.

The boiler house, which is shown in fig. 6, contains six Babcock & Wilcox boilers arranged in a battery which faces the coal bunkers: the latter are filled direct from coal wagons on the adjacent railway siding.

The boilers are hand fired with smudge, the low cost of which, some 3s. 7d. per ton delivered, is obviously in the interests of economical operation.

The boilers, as a whole, have 14,260 sq. ft. heating surface, and are rated for evaporation at 43,500 lb. of steam per hour, at the working pressure of 150 lb. per sq. in.

Two economisers, by Messrs. Green and the Clay Cross Co., with 160 and 180 tubes each respectively, are erected in a by-pass to the main flue, which runs behind the boilers and terminates in a stack some 120 ft. in height and 7 ft. sq. internally.

The feed pumps, which are installed at the end of the boiler house, consist of four Worthington double outside ram pattern pumps, each with a capacity of 600 gallons per hour: these draw from a common suction leading from a straining tank in connection with the adjacent River Hipper.

A reserve feed tank of 3,000 gallons capacity is provided,

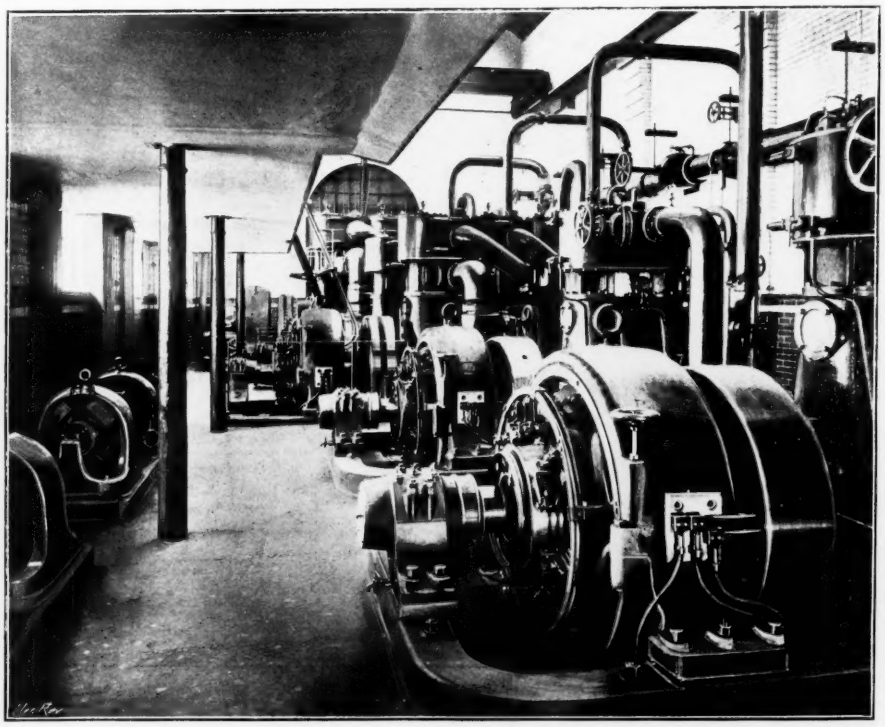


Fig. 4.—Belliss-Westinghouse Generating Plant, &c.

filled either from the river or town supply. With the feed pumps is also installed a Berryman feed water heater, into which the feed pumps and condensing engines exhaust. The

feed to the boilers is in duplicate, either through the feed heater and economisers or direct in case of emergency.

The steam pipe arrangement consists merely of an interconnecting header in the engine room, with branches to the various engine and boiler units on either side; the "Holly gravity" return system is in use for returning the drain and separator water direct to the boilers.

In the engine house are installed five Belliss-Westinghouse steam generators, the engines being of the former firm's normal high speed forced lubrication type, and the generators, in each case six polar machines, are with one exception compound wound. Views of the generating plant are given in figs. 2 and 4.

The original plant consisted of two compound engines direct coupled to 100-KW. generators with a speed of 360 r.p.m.

Two further triple-expansion engines coupled to 200-KW. machines, and, lastly, a similar engine coupled to a 400-KW. generator have also been installed.

All the engines exhaust into a common header in the basement with an automatic atmospheric exhaust at either end: the header is connected at intermediate points to four self-contained Worthington steam-driven jet condensers. A view of the condensing plant in the basement is shown in fig. 5. The condensing water flows into the condensers from the River Hipper, an adjacent stream, through two settling tanks, the last one of which contains both the condenser and feed suctions, the discharge leading back to the stream lower down.

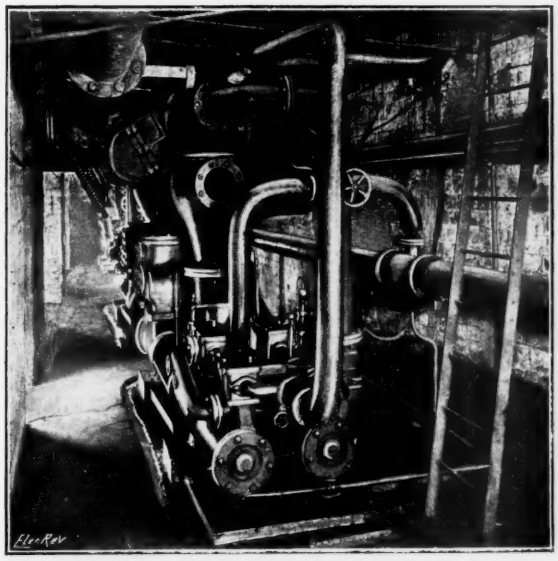


FIG. 5.—VIEW OF THE CONDENSING PLANT.

In addition to the above, a balancer and a booster are installed in the engine room. The former, consisting of two four-pole machines direct coupled will deal with an out-of-balance current of 60 amperes; the latter machine is of 15 KW. capacity, and similar in appearance, but constructed for use with the battery. The battery in question is installed in an adjoining battery room, and consists of 280 Chloride cells of 600 ampere-hours rated capacity, and is used on the lighting supply only, the regulation being effected on the neutral cells.

FIG. 6.—THE BOILER HOUSE.

For repair and erection work, a 10-ton hand-operated travelling crane is installed in the engine room.

The switchboard, figs. 2 & 3, occupies a gallery extending across one end and side of the engine room; the lighting board contains five generator and a similar number of feeder panels, together with battery, booster and balancer panels, &c., constructed in white marble; the tramway board, of similar design, is equipped for the control of the four compounded generators, six feeders, and also contains main meter and B. of T. panels.

The switchgear is of normal design, and can be seen in our illustrations.

The whole of the generating plant and switchgear was supplied by the British Westinghouse Co.

The lighting network consists of triple-concentric lead-covered cable laid solid in stone troughing with brick covers. The traction feeders, on the other hand, consist of lead-covered cable drawn into ducts as far as the centre of the town, from which point armoured cables, laid direct, run to the extremities of the tramway routes. The whole of the cable work at Chesterfield has been carried out by the British Insulated and Helsby Cables, Ltd.

The development of the electricity supply undertaking has apparently

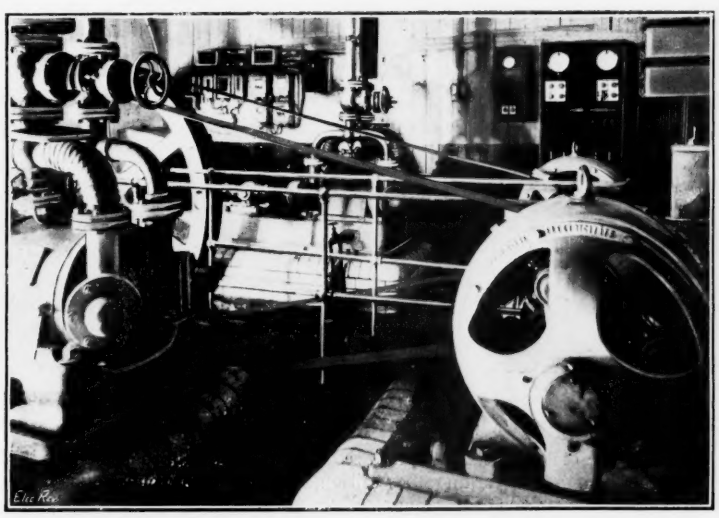


FIG. 7.—MOTOR-DRIVEN COMPRESSORS AT COLD STORAGE PLANT.

surpassed the most sanguine hopes of its promoters, the station being full of plant even now, and Mr. Acland being confronted with the certainty of further extensions in the near future.

Fig. 8.—Track under Construction.

The supply connections are at present equivalent to 40,000 8-c.p. lamps, and include some 500 h.p. of motors in addition to the tramway load.

The department hires out motors, and the local brewing, printing, ice-making and cold storage industries, together with numerous isolated traders, have favoured the modern method of driving. A local brewery is exclusively equipped for electric driving and lighting, some 70 h.p. of motors being installed; and we illustrate in fig. 7 the compressor room, with its electrical plant, of the local cold storage company.

The question of supplying outlying consumers on the tramway routes is one which Mr. Acland has been called on to consider. We understand that he has solved the difficulty in the case of certain motive power consumers by tapping tramway feeders; and, further, that he contemplates supplying certain prospective lighting consumers in another direction, in this case, however, through a motor-generator working in conjunction with a B.T.H. voltage regulator. The minimum of repairs have characterised the working of the generating station, which, with its 18½ per cent. load factor and facilities for obtaining cheap fuel and water, has enabled Mr. Acland to show excellent working costs.

The tramways undertaking consists of some 3½ miles of single track with loops, and ½ mile of double track in the

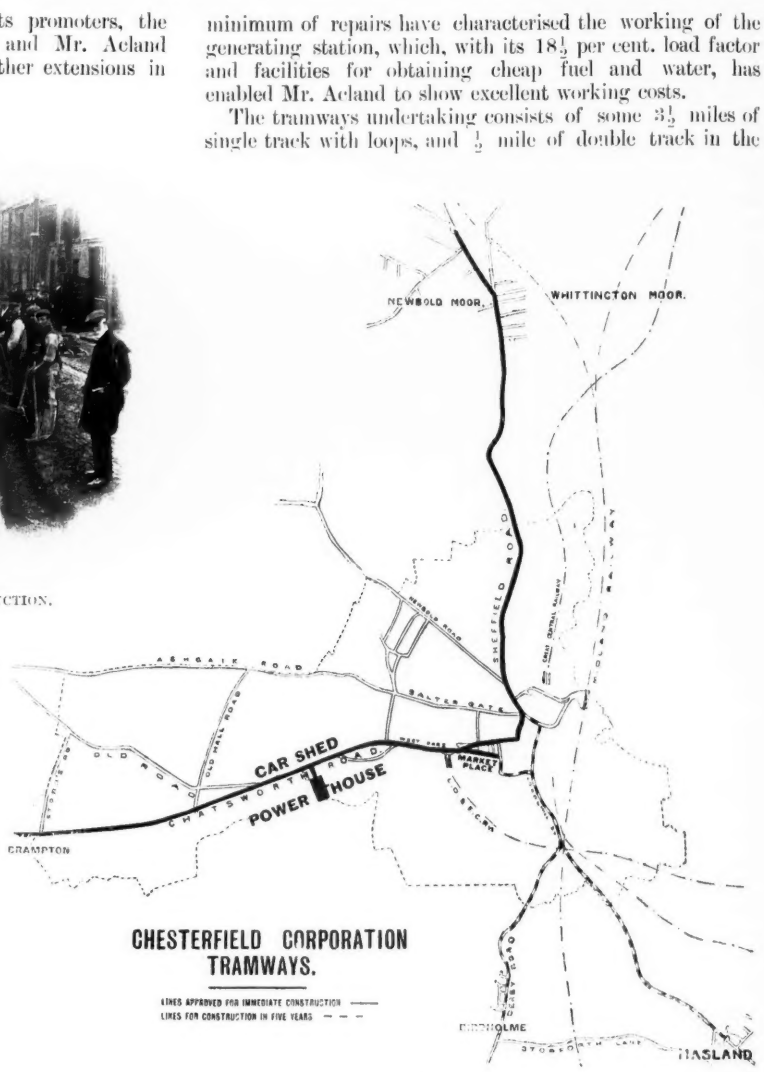


Fig. 9.—Plan of the Tramway Routes.

centre of the town; the route extends from Brampton on the one side, through the town to Wittingdon on the other side.

The track is constructed to the 4 ft. 8½ in. gauge, with

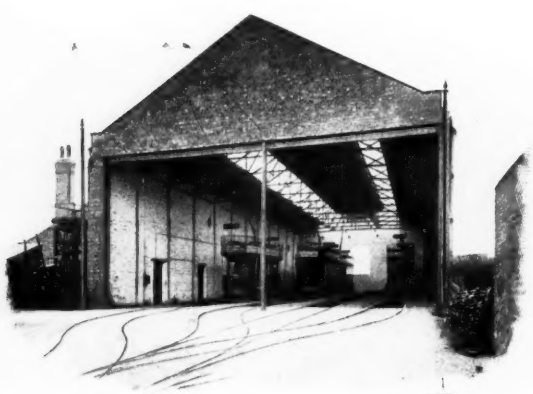


Fig. 10. The Car Shed.

Fig. 11. View showing Span Wire Construction: Chatsworth Road.

method, of course, necessitates a re-arrangement of certain of the traction feeder circuit-breakers, but obviates the laying of lengthy independent feeders.

We gather that a complete absence of breakdown and a

British Standard section rails of 96 lb. to 100 lb. in weight, according to position, resting on a concrete bed; Cooper Anchor joints are used throughout. The overhead work follows both span wire and bracket arm construction; and

4/0 grooved trolley wire and mechanical ears have been employed throughout.

Some 12 cars are provided for the traffic which fluctuates considerably, and, as in most mining districts, attains a maximum on Saturdays. All the cars are of the double-deck type, with semi-reversed staircases, and are constructed to carry 56 passengers; the car bodies, as also the trucks, of the "radial" type, were supplied by the Brush Co., and the steady running of the combination is a feature worthy of remark.

Each car has a Westinghouse equipment, including two 25-H.P. motors with controllers, &c., and is provided with two brakes only, viz., the hand and Newell magnetic track brake, the latter, it may be noted, being the service brake regularly used on the gradients.

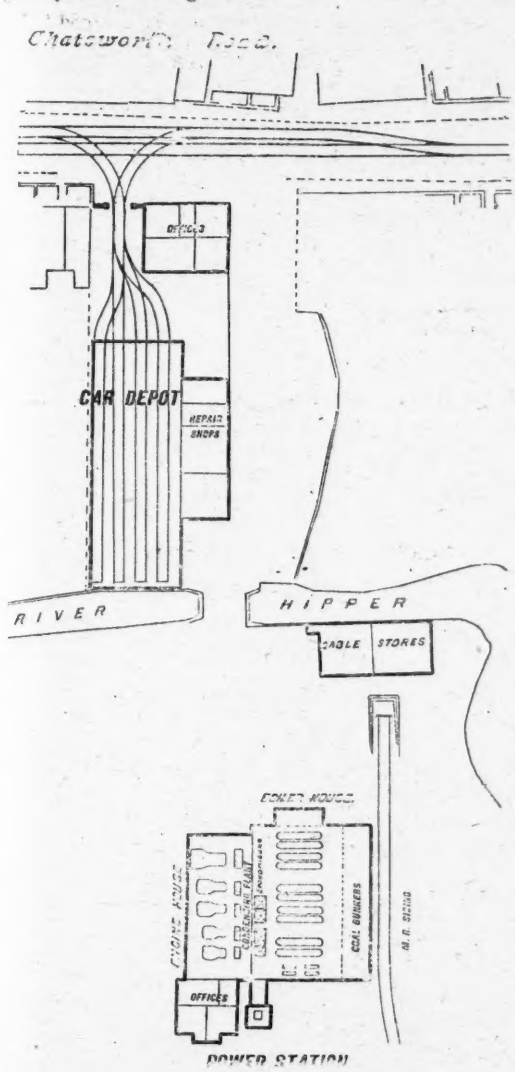


Fig. 12.—Plan of the Power Station and Car Depot.

Lifeguards of the Hudson & Bowring pattern are also provided to all the cars.

The car-shed is adjacent to the power station; it is provided with ample facilities in the ways of repair shops, inspection pits, &c., and it also adjoins the offices of the electricity and tramways department which face on to the Chatsworth Road route. Tramway views are shown on the opposite page.

From the above it will be seen that Chesterfield can boast a modern tramway equipment, the distinctive features of which represent up-to-date construction.

The British Insulated and Helsby Cables, Ltd., were the contractors for the whole of the authorised equipment of the tramways, which, as will be seen from our diagram of routes, fig. 9, are not complete.

In concluding our remarks, we may again mention that Mr. Acland has controlled the destinies of the combined undertakings since their inception, and it is to his energy that Chesterfield owes its progress electrically.

Not content with supplying energy to the premises of the consumer, he takes a personal interest in seeing that the latter utilises it to the best advantage, a course which is obviously in the best interests of the undertaking.

It is interesting to note that since Mr. Acland distributed among his consumers a "Card of Hints" as to the proper use of incandescent lamps, some thousands of the latter have been sent in to the works with the request that they shall be tested and only returned if fit for use, new ones to be sent to replace any rejected lamps. This, of course, is a very satisfactory arrangement, which ought to be, in some form or another, in general use.

In conclusion, our thanks are due to Mr. Acland for the facilities which he kindly extended to us on the occasion of our visit, also to his chief assistant, Mr. H. L. Percy, for assistance rendered.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barcelona.—March 31st. Tenders invited for the concession of an electric tramway in Barcelona. An application for this concession has already been made by the Barcelona and San Andrés Tramway Co., who, at the same rates, will enjoy certain preferential rights over other tenderers. The competition will turn, in the first place, on the reduction of the tariffs proposed, and if two or more identical propositions are made, a further verbal adjudication will take place with a view to a reduction of the period of the concession (60 years). The *Board of Trade Journal* announces that a deposit of 2,576 pesetas (about £83) is required to qualify any tender.

Barnes.—February 12th. Steam dynamo and switchboard panels for the U.D.C. See "Official Notices" January 19th.

Battersea.—February 20th. Stores for the electricity department. See "Official Notices" to-day.

Bermondsey.—February 22nd. Stores for the B.C. electricity and destructor works. See "Official Notices" to-day.

Bilston.—March 12th. Electric lighting of the new schools now being erected at Stonefield. See "Official Notices" to-day.

Blackburn.—February 12th. Stores for the Electricity and Tramways Committee. See "Official Notices" January 26th.

Brazil.—A Vienna paper says that the Municipal Chamber of Floreanopolis, in the State of Santa Catharina, Brazil, recently held a competition for the electric lighting of the town and the construction of an electric tramway. As only one tender was submitted, it has been decided to call for fresh tenders.

Canary Islands. — February 14th. The Spanish Ministry of Post and Telegraph authorities are inviting tenders for the establishment and working of a telephone exchange in the town of Arucas. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Correos y Telegrafos, Carretas 10, Madrid.

Cardiff.—February 16th. Cooling towers, electrically-driven pumps, pipe work, &c., for the Corporation Roath Power Station. See "Official Notices" January 26th.

Clyde Navigation.—February 12th. Electrical cable and conductor installation for Clydebank Dock. See "Official Notices" January 26th.

Chile.—March 15th. The Director of State Telegraphs is calling for tenders for the supply of 2,250 metric quintals of wire, 27,500 insulators, 20,000 rolls of Morse paper, and other telegraphic materials. Tenders, says the *Board of Trade Journal*, must be accompanied by a deposit note for a sum equal to 5 per cent. of the value of the articles tendered for.

Dover.—February 16th. One 350-KW. combined steam generator set for traction purposes for the Electricity Department. See "Official Notices" January 26th.

Germany.—February 16th. The *Board of Trade Journal* says that tenders are being invited for 18 electric cranes at Hamburg. Conditions, for 3 marks, from the Finance Administration, Hamburg.

Halifax.—February 27th. A 30-35-B.H.P. motor tower wagon for the tramways department. See "Official Notices" to-day.

Hornsey.—February 26th. Cables, junction boxes, fuse boxes, meters and cable stores. See "Official Notices" to-day.

Kingston-upon-Hull. — February 12th. Air-space telephone cable and extension of existing multiple switchboard for the Corporation telephone equipment. See "Official Notices" January 19th.

Leyton. — February 15th. Underground electrical feeders for the U.D.C. tramways. See "Official Notices" February 2nd.

Madrid.—February 20th. Tenders to Chief Telegraph Office, 10, Carretas, Madrid, for the supply of 55 tons of galvanised wire, 4 millimetres in diameter; 15 tons of bronze wire, 3 millimetres in diameter, and 5 tons of bronze wire, 2 millimetres in diameter. Some further particulars are given in the *Board of Trade Journal*.

Madrid.—February 26th. Tenders are invited at the Chief Telegraph Office, 10 Carretas, Madrid, for the supply of 60,000 porcelain insulators (No. 2, Spanish telegraph type), to be delivered in five equal lots, at Madrid, Barcelona, Cordoba, Valladolid and Zaragoza. The maximum price at which tenders will be received is 80 centimos per insulator. A deposit of 5 per cent. of the value of the goods at the upset price is required to qualify any tender. The *Board of Trade Journal* says that local representation is necessary in tendering in Spain.

Pontypridd.—February 13th. One 300-KW. steam dynamo for the U.D.C. See "Official Notices" January 19th.

Pontypridd.—March 3rd. Reservoir, condensing plant, cooling tower and tank, and artesian well for the U.D.C. See "Official Notices" to-day.

Rathmines and Rathgar.—February 17th. Coals, carbons and general stores for the electricity department. See "Official Notices" February 2nd.

Roumania.—The Municipality of Giurgevo will shortly invite tenders for the installation of an electric lighting system in that town, at an estimated cost of 960,000 fr. (about £38,400). *Board of Trade Journal.*

Salford.—February 17th. Stores, &c., for the electricity department. See "Official Notices" February 2nd.

Shanghai.—February 22nd. One 800-KW. horizontal steam turbo-alternator with condensing plant, for the Municipal Council. See "Official Notices" January 26th.

Sheffield.—February 19th. Stores for the Corporation Tramways Department. See "Official Notices" February 2nd.

Stoke Newington.—February 19th. Sub-station electric lighting and other work for the Council. See "Official Notices" to-day.

Sunderland.—March 2nd. Feed pump, cooling tower, surface condenser, coal bunkers, &c., for the Electricity Department. See "Official Notices" January 26th.

Sydney (N.S.W.).—May 7th. Boilers, stokers, pipework, turbo-alternator, sub-station machinery, switchboards, &c., for the Council. See "Official Notices" to-day.

Wakefield.—February 17th. Water softening and purification plant for the electricity department. See "Official Notices" February 2nd.

West Ham.—February 16th. One 1,500-2,000-KW. two-phase turbo-generator, one 500-KW. motor-generator, and switchgear for the same, for the Council. See "Official Notices" February 2nd.

West Hartlepool.—February 26th. One 500-KW. high-speed engine and continuous-current dynamo for the Corporation. See "Official Notices" to-day.

CLOSED.

Birkenhead.—The T.C. has accepted the tender of Messrs. Millars, Karri & Jarrah Co. (1902), Ltd., of London, for the supply of 170,000 Jarrah wood blocks for the tramways, at £10 13s. per 1,000.

Birmingham.—The Corporation Tramways Department has placed an order for 75 "Aston-Worsley" weight-relieving arc lamp clutches, winches, &c., for the new car-sheds, with Messrs. Veritys, Ltd., of Birmingham.

Cardiff.—The following tenders were received by the Committee for telephones, fire alarms, tell-tales and electric bells, &c., for the Whitchurch Asylum:—

J. B. Saunders & Co., Cardiff ..	(accepted)	£1,291 19
Gent & Co., Leicester		1,320 0
National Telephone Co.		1,329 17
Cox-Walkers, Darlington		1,454 0

Croydon.—The T.C. has accepted the tender of Messrs. Dick, Kerr & Co., Ltd., for the supply of a 1,000-KW. direct-current generator, at £6,975, and that of Messrs. Siemens Bros. & Co., Ltd., for traction feeder panels, at £198 10s.

Glasgow. — A protracted discussion took place at a meeting of the T.C. in connection with the proposal to give an order for ten new boilers, required for Port Dundas and St. Andrew's Cross electricity stations, to Messrs. Babcock & Wilcox. The approval of the minutes was moved by Mr. Willock, the convener of the Electricity Committee. An amendment was proposed that six boilers be given to Messrs. Babcock & Wilcox and four to the Stirling Boiler Co. On a vote the amendment was carried by 36 votes to 26 for the motion.

Leyton.—The U.D.C. has accepted the tender of Mr. Walter Manders for the construction of the permanent way of the tramways, at £127,485 11s. 5d.

London.—ISLINGTON.—The B.C. has accepted the tender of the British Thomson-Houston Co., Ltd., for six electric motors, and alterations to shafting at Caledonian Road Baths, at £225 10s. 2d.

SOUTHWARK.—The B.C. has placed an order with the General Electric Co. for 16 automatic switch circuit breakers, at £11 each.

HAMMERSMITH.—The B.C. has placed an order with Messrs. Babcock & Wilcox for a coal-weighing apparatus to be installed at the electricity works at a cost, including two sets of overhead rails, weigh-hoppers, shoots, mouthpieces, &c., of £206.

Newquay.—Messrs. Newtons, Ltd., Taunton, have been instructed by Messrs. Foote & Milne, of London, the contractors for the Newquay Electric Light and Power Co., Ltd., to supply the generators and boosters for the new central station.

Reigate.—The T.C. has accepted the tender of the Aron Electricity Meter Co., Ltd., for the maintenance of electricity meters at 4s. each for the first year, and 3s. for the second year.

Rotherham.—The Corporation Tramways Committee has accepted the tender of Messrs. Dick, Kerr & Co., Ltd., for the supply of six covered tops for tramcars of the Leicester type, at £115 each.

Wimbledon.—The T.C. has accepted the following tenders in connection with the electricity undertaking:—

The Mid-British Co., supplying two 6-ton traversing jacks, and two 1½-ton bottle jacks, £4 16s.
J. H. Tucker & Co., 10-way street lighting switchboards, £5 11s. 3d. each.

FORTHCOMING EVENTS.

To-day's Events (Friday, February 9th). — At 7.30 p.m. I.E.E. (Manchester Students). Mr. H. A. Carney on "Electrical Instruments."
At 8 p.m. Physical Society. Annual general meeting. Address by the President-Elect, Prof. J. Perry.
At 8 p.m. I.C.E. (Students). Mr. R. H. Mackie on "Electric Driving at the Locomotive Works of the N. L. Railway."

Saturday, February 10th.—Junior Institution of Engineers. Anniversary dinner at the Hotel Cecil.
At 7.30 p.m. Electrical Trades Union (London). Concert and dance at Battersea Town Hall.
I.E.E. Students' visit to G.P.O. Telephone Exchange postponed to March 3rd.
At 2 p.m. North of England Institute of Mining and Mechanical Engineers. At Newcastle. Mr. G. C. Wood on "Determination of the Specific Electrical Resistance of Coal, Ores, &c." Also various other papers.

Monday, February 12th.—At 8 p.m. I.M.E. (Graduates). Prof. W. C. Unwin on "The Niagara Power Stations."
At 8 p.m. Society of Arts. (Cantor Lecture.) Sir Wm. White on "Modern Warships." (Lecture III.)

Tuesday, February 13th.—At 7.30 p.m. I.E.E. (Manchester). Mr. M. B. Field on "Idle Currents."
Association of Engineers-in-Charge. Dance.
At 8 p.m. I.E.E. (Glasgow). Mr. G. L. Black on "The Maintenance of Underground Mains." Adjourned discussion.

Wednesday, February 14th.—At 7.30 p.m. I.E.E. (Birmingham). Mr. R. N. Tweedy and Mr. H. Dudgeon on "Notes on the Construction and Maintenance of Overhead Equipment."
At 8 p.m. Association of Engineers-in-Charge. Mr. H. C. H. Shenton on "Small Water Supplies."
At 2 p.m. I.C.E. (Students) Visit to N.L.R. Bow Locomotive Works.

Thursday, February 15th.—At 7.15 p.m. I.E.E. (Leeds). Mr. G. Wilkinson on "Waste in Incandescent Electric Lighting and Some Suggested Remedies."
At 7.30 p.m. I.E.E. (Students). Second Annual Dinner at Holborn Restaurant.
Rugby Engineering Society. Mr. W. J. Parish on "Lubrication."

Friday, February 16th.—At 8 p.m. I.M.E. Mr. G. J. Churchward on "Large Locomotive Boilers."
At 8.30 p.m. Chemical Society. Meeting.
At 9 p.m. Royal Institution. Mr. W. C. D. Whetham on "The Passage of Electricity through Liquids."
N.E. Coast Institution of Engineers and Shipbuilders. Meeting.

Saturday, February 17th.—At 7.30 p.m. Glasgow Technical College Scientific Society. Mr. G. Inglis on "The Inglis Patent Boiler."
At 7.30 p.m. Birmingham and District Electric Club. Mr. J. G. Moon on "The Production of Gas for Industrial Purposes."

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

The following orders are issued:—

Monday, February 12th.—"A" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.
Tuesday, February 13th.—"B" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.; medical examination recruits, 7 p.m.
Wednesday, February 14th.—"A" badge examination for "C" and "D" Companies.
Thursday, February 15th.—"C" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.
Friday, February 16th.—"D" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.
Saturday, February 17th.—Week-end instruction for Birmingham detachment "C" Company.

J. H. S. Phillips, Captain E.E.
For O.C.E.E.R.E. (V.).

NOTES.

Leyton Tramway Contract.—Too late for inclusion in our "Correspondence" columns, we have received the following letter from the Leyton U.D.C.:—

"The electrical engineer to the Council has submitted the article entitled "A Curious Specification," appearing in the issue of the Electrical Review of the 2nd inst., to the Electric Lighting and Tramways Committee, and the Committee desire to state, in reply thereto, that the specification referred to was submitted to the Committee and the Council before tenders were accepted, and that the inclusion in such specification of the stipulation that certain articles were to be obtained from particular makers was approved.

"C. G. Musgrave, *Chairman.*
"R. Vincent, *Clerk to the Council.*"

Electric Shock Fatalities.—Before Sheriff Scott Moncrieff and a jury in the Justiciary Buildings, Glasgow, on Thursday last week, an inquiry under the Fatal Accidents (Scotland) Act was held into the circumstances attending the death of Alexander Duncan Melville, 24 years of age, an electrical engineer in the employment of the British Westinghouse Co., which took place at the new sub-station of the Corporation Electricity Department in Stirling Road on the morning of December 27th. William Scott, an electrical engineer in the employment of the Corporation Electricity Department, said that on December 27th last he was working along with the deceased at the sub-station in Stirling Road. Deceased was in charge of a new machine, which was being erected by the British Westinghouse Co. Witness and Melville were making the board ready and preparing the switches for the high-tension current going on. When the accident happened Melville was in the act of drawing out an isolating switch. His hand was on the switch when the full current of 6,500 volts was suddenly turned on, killing him instantly. Deceased used his hand instead of the pole for removing the switch. So long as the current was off it was not an uncommon thing to use the hand. Intimation that the current was to be turned on should have been received by telephone from the generating station at Port Dundas. On the morning in question no such notice was given. Deceased was thoroughly familiar with the working of the plant, and knew that the pole ought to have been used. It was assumed that the current would be kept off until telephonic intimation was made that it was to be turned on. It was the duty of the engineer in charge at Port Dundas station to make that intimation.

By Mr. Murray, law agent for the deceased's relatives: There was a telephonic communication received from Port Dundas previous to the accident. The message was whether the board was clear. Witness answered that communication, replying that the board was not clear. Melville was not in the station at this time. He came in about two minutes afterwards, and they both proceeded to the board for the purpose of clearing it. It was witness's intention after making the board ready to telephone Port Dundas to put on the power. No communication to this effect was sent. Had deceased not been there, witness would have taken out the switches himself, and he would have done so with his hand. It must have been through some mistake or misunderstanding at Port Dundas that the current was put on.

Thomas Robertson, electrical engineer in the employment of the Corporation, said he was working on the occasion referred to along with Scott and Melville. Replying to Mr. Murray, he said that if he had known that the current was on, he would not have been on the gallery where he was at the time of the accident. He understood the current was off, and he did not know of any notice being given that it was to be put on.

At the request of the foreman of the jury, Mr. Robert Williamson, engineer in charge of Port Dundas power station, was examined. He went on duty on the morning in question at 8.40, and shortly afterwards he telephoned Waterloo sub-station and inquired if the board was ready for the current being put on. The answer was satisfactory, and, after waiting five minutes, which was the usual thing for him to do, he turned on the current. He next communicated with Stirling Road station, and the answer he got back was that the board was clear; that was a few minutes before 9 a.m. He rang a second time before putting on the power, and he got a similar message that all was clear. There would be an interval of perhaps five minutes between the two messages. A minute afterwards he turned the current on. He did not recognise the voice of the person who answered the messages at Stirling Road, nor could he say if it was the same person who replied on both occasions.

By Mr. Murray: It was witness's duty to ring up the sub-stations before turning on the power, and it was the duty of a certain Corporation official to answer the 'phone at the other end. He knew the man Scott, but could not say if it was his voice he heard at the telephone that morning. He was quite certain he rang up Stirling Road twice. The jury returned a formal verdict of accidental death.

An inquest was held at Southport on Friday night touching the death of Thos. Jepson, aged 29, who met with a fatal accident at the premises in Chapel Street of Messrs. Seymour, Mead & Co., provision merchants. According to the evidence, Jepson, who had been employed for five years by the firm as grocer's assistant, and had been in charge of the engine and dynamo for about 12 months, was in the engine room on Wednesday morning, the 31st ult., when he suddenly called to a fellow employé to stop the engine. The electric light went out at the same time, and the unfortunate man was found to be crouching against the dynamo. His right arm was bruised and almost severed at the elbow, and the flesh was torn off the forearm. He died a few minutes later at the infirmary. A witness said he believed that the deceased's arm had been drawn under the belt on the driving-wheel of the dynamo. A juryman asked if it was customary for a grocer's assistant to look after an engine of that kind. Mr. Mead, managing director of the firm, replied that it was not customary to employ a fully-qualified electrician to look after such a plant. Deceased had always been fond of the work. The jury returned a verdict of Accidental death, and announced that there was not sufficient evidence to show how the accident happened.

Call Relay for Wireless Telegraphy.—We recently had the pleasure of inspecting a new and long-distance call relay invented by Mr. H. W. Sullivan, of 19, Great Winchester Street, E.C. The relay is intended to be energised by an electrical impulse received upon an aerial and acting upon an electrolytic or other type of coherer, and thus closing a local circuit; the indication of a call is given either by ringing a bell or by a visual signal, or both.

The instrument consists of a permanent magnet and suspended moving coil, practically identical with those used in Mr. Sullivan's moving-coil galvanometers; but in this case the moving coil carries an arm, provided with platinised contacts on either side at its outer end. Facing these contacts are two stationary contacts, likewise platinised, and carried on the ends of light springs. The passage of a current through the moving coil deflects the latter to one side or the other, and thus causes the contacts to complete the circuit of a local battery and bell. The principal improvements consist in the arrangement of the spring contacts, which are provided with adjustments both for rigidity and for position, while stops are provided which prevent the spring contact from sticking to the moving contact, and thus following up the latter. So great is the sensibility of the contrivance that, as was demonstrated to us, the current from a single cell through more than 9 megohms (the highest resistance available at the time) sufficed to operate the relay with certainty; this represents a very considerable advance in sensibility compared with the relays hitherto available. A further refinement has been effected by mounting the moving contact also on a spring arm carried by the coil, so that there is a double spring effect, and contact is maintained for a longer period than in the earlier patterns. The instrument is insensitive to vibrations, being so mounted that even shocks and jarring on the table itself do not cause false contacts. The moving coil carries a mirror, by means of which, with a special lens, a large spot of light can be thrown on the wall of the room 12 ft. away, and the motion of this through a wide angle attracts attention, even in daylight, in the event of a defect occurring in the bell circuit. The moving coil, with its suspension and all the contacts, can be removed bodily and replaced by a duplicate in a few seconds, guides being provided to ensure the certainty of its being correctly situated and of the circuit connections being automatically completed. Obviously this ingenious instrument fills a want, and Mr. Sullivan is to be congratulated upon the successful results which he has attained.

Institution Notes.—Leeds Association of Engineers.—Mr. Francis J. Sharr delivered a lecture on 25th ult. on "Modern Engineering Workshop Design."

Society of Engineers.—The President's Gold Medal was on Monday presented to Mr. Sherard Cowper-Coles for his paper on "The Metallic Preservation and Ornamentation of Iron and Steel Surfaces;" and a Society's Premium of Books was presented to Mr. William Pollard Digby for his paper on "Statistics of British and American Rolling Stock." The President for the present year, Mr. Maurice Wilson, delivered his inaugural address.

Royal Society.—The following papers were down for reading yesterday afternoon:—

"Polarisation in Secondary Röntgen Radiation," by Dr. C. G. Barkla. Communicated by Prof. J. J. Thomson, F.R.S.
"Ionic Size in Relation to the Physical Properties of Aqueous Solutions," by W. R. Bousfield, K.C. Communicated by Prof. J. Larmor, Sec. R.S.
"Explosions of Coal-Gas and Air," by Prof. B. Hopkinson. Communicated by Prof. Ewing, F.R.S.
"On Periodicities in Sunspots," by Prof. A. Schuster, F.R.S.

A Telephone Ball.—At the Old Ship Assembly Rooms last Friday evening, the staff of the Brighton Corporation Telephone Department held their second annual ball. A couple of hundred guests were present. The visitors were received by the engineer, Mr. D. J. Barnes, and Mrs. Barnes.

Appointments Vacant.—Professor of Electrical Engineering for Armstrong College, Newcastle-upon-Tyne (£500 and one-third of fees); assistant electrical engineer for Bridlington (£100).

Educational Note.—UNIVERSITY OF SHEFFIELD.—A handsome souvenir of the opening of the new Engineering and Metallurgical Laboratories has come to hand from the Department of Applied Science. Illustrations of the new University buildings and of the Applied Science Department are given, and views of the various laboratories and workshops. The letterpress describes the origin and development of the University, and lays stress on the serious intentions of the organisers and the abilities of the technical staff, which no one will dispute. The position of the University in Metallurgy is justly styled unique; but there is no danger that the other branches of engineering science will be sacrificed to it. On the contrary, the engineering laboratories are both numerous and well equipped; Prof. W. Ripper, M.Inst.C.E., is head of the engineering department, assisted in electrical engineering by C. H. Hainsworth and others.

New Glow Lamp.—In the *Elektrotechnik und Maschinenbau* for the 4th inst. there appears an article by Herr Joh. Kremenezky, an incandescent lamp manufacturer of Vienna, on a new glow lamp with metallic filament, invented by Dr. Hans Kuzel, of Baden, Vienna. The exact composition of the filament is not disclosed, but a number of tests are given. About 100 lamps have been made, and some of them have been officially tested in the Government laboratories. Of two lamps which were supplied in August last, one gave 13·17 normal candles with 0·461 ampere at 32 volts, at the rate of 1·12 watts per candle; after burning for 1,010 hours the filament broke, but reunited as in the Tantalum lamp, and the lamp continued burning until in all 1,468 hours had elapsed. In the latter period of its life, owing to the shortening of the filament, the current rose to 0·482 ampere, and the candle-power to 16·72, while the watts per candle fell to 0·992. The second lamp started at 1·08 watts per candle, which rose to 1·16 in 1,468 hours; at 1,490 hours the filament broke and reunited, the watts per candle falling to 1·07, and the lamp was still burning after 3,537 hours, the watts per candle then being 1·23 and the loss of candle-power being 10·9 per cent. Other tests are given, showing still better results. The lamps can be made for pressures up to 110 volts, and it is stated that the materials and manufacture are inexpensive. [Note that the "normal candle" is only $\frac{7}{8}$ of the British standard candle.]

Cable Companies' Annual Dinner.—The twelfth annual dinner and smoking concert of the cable companies in London was held at the Talbot Restaurant, London Wall, on Saturday evening last, when a record number (upwards of 120) sat down, all the companies being well represented. The chair was occupied by Mr. F. J. Williams (Direct United States Cable Co.), the vice-chair by Mr. G. J. Hodson (Commercial Cable Co.). During the dinner a large number of telegrams of congratulation were received from cable stations and colleagues in all parts of the world. The toast of "The King and the President of the United States," proposed by the chairman, was enthusiastically honoured, while with hardly less warmth were received the toasts of "Our Annual Dinner," proposed by the vice-chairman, and "The Visitors," proposed by Mr. F. Mockford, of the Anglo-American Telegraph Co. After the dinner a very successful smoking concert was given, the performers, both vocal and instrumental, being members of the staffs of the various companies.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*]

Central Station Engineers.—At the meeting of the Bridlington T.C. on January 31st, it was decided to increase the salary of Mr. SIMPSON, assistant electrical engineer, by £10 a year until a maximum of £130 is reached, as some inducement for him to remain, he having tendered his resignation. A reference to this matter appeared on page 27 of our January 5th issue.

The Darlington T.C. has increased the salaries of Mr. HEWITT and Mr. DAVIS, shift engineers, by £13 and £10 per annum respectively.

The Wrexham T.C. has appointed Mr. C. A. JAMES, of Southampton, as switchboard attendant at the Electricity Works.

Mr. W. H. WILSON, of Lincoln, has been appointed manager of the Electricity Works of the Sleaford U.D.C. in succession to Mr. YATES, who has proceeded to Leamington.

Mr. DENNIS, of the Eastbourne Electricity Department, has been appointed as improver in the Acton U.D. Council's Electricity Department.

Mr. JOHN PRESTON, switchboard attendant at the Rochdale electricity works, has been appointed engineer-in-charge at the electricity works of the Radcliffe U.D.C.

Mr. A. J. L. PLUNKET has resigned his position as managing engineer to the Merthyr Electric Traction and Lighting Co., Ltd., which he has held for the last three years, to take up an appointment with the Newcastle Electric Supply Co., Ltd.

Tramway Officials.—Mr. E. CARROLL, late inspector of the Swindon Corporation Tramways, has been appointed chief inspector on the Dartford Light Railways.

Mr. J. M. M'ELROY, manager of the Manchester Tramways, has just been appointed by the Corporation of Newcastle-on-Tyne to act as their arbitrator in the settlement of the grievances which led to the recent strike of tramway employés.

Following the recent decease of Mr. C. R. BELLAMY, an important re-arrangement of the control of the Liverpool tramways department, in relation with the electric supply department of the city, is about to be made. The change will be especially important, as it will probably set a precedent which may be largely followed. The scheme, as now before the Council, will place the control of the tramways, as regards operative electrical work, with the heads of the electrical department, while bringing in expert supervision on the accountancy side, but leaving the working of the traffic, as a department, under a manager. With the increase of responsibility on the electrical side, consequent on the large increase of electrical generating plant in the city, and the practical completion of the constructional work of the Liverpool tramways, it was regarded as certain that, sooner or later, a re-arrangement of the duties of control would take place. The recent death of Mr. Bellamy made an opportunity for such a re-arrangement, and the opportunity is being taken. The details of the re-arrangement proposed by the Tramways Committee are:—Mr. C. W. MALLINS, present traffic superintendent, at a salary of £500 per annum, to be appointed traffic manager, at a salary of £600, increasing on January 1st, 1907, to £700 per annum; Mr. THOS. BULMER, deputy accountant in the controller's department, at a salary of £400, to be appointed, in addition, secretary to the tramways department, at a total salary of £600 per annum; Mr. A. B. HOLMES, consulting city electrical engineer, to undertake similar duties of control and supervision of the electrical and mechanical departments of the tramways as he now exercises for the electric supply department, an extra £250 per annum to be paid to him for such additional services; Mr. ALFRED CLOUGH, resident electrical engineer of the electric supply department, whose salary is £900 per year, to become resident electrical engineer to the tramways department, at a total salary of £1,000 per annum, increasing, on January 1st, 1907, to £1,100 per annum.

General.—Mr. A. C. HEAP, M.I.E.E., who recently resigned his position as manager of the switchgear department of the General Electric Co., Ltd., has now entered into partnership with Mr. A. ECKSTEIN, under the name of ECKSTEIN, HEAP & Co. Mr. Heap only joined the General Electric Co., Ltd., in February last year. Previous to this he was for many years chief engineer to Messrs. Elliott Bros., of Century Works, Lewisham. The following gentlemen have also joined Messrs. Eckstein, Heap and Co.:—Mr. PERCY B. HALL, A.I.E.E., who recently resigned the position which he has held for some considerable time with the General Electric Co., Ltd., formerly as manager of their switchboard department and latterly as assistant manager of the switchgear department; Mr. D. B. MELLIS, who recently resigned the position which he has held for many years with the General Electric Co., Ltd., as manager of the instrument department; Mr. F. PANTER, who for a number of years has held the position of shop manager of the instrument department with the General Electric Co., Ltd., and has recently resigned this position; and Mr. A. R. H. JACKSON, who has resigned the position which he has held for a considerable time with the General Electric Co., Ltd., as chief draughtsman of the instrument department.

Last Saturday week 50 of the staff of the Arc Works, Chelmsford, dined together, Mr. A. J. HODGSON, the general manager, presiding. The toasts were: "Continued success to Crompton & Co.," submitted by Mr. P. G. CHEVERTON, who has entered upon his twenty-first year with the firm, to which Mr. Hodgson replied; "Our Foremen," "The Chairman," and "Our Musical Friends."

Dr. ANTOINE HOFFMANN, Chevalier d'Ostenhof, is acting in place of Dr. Rodolphe Neubauer, the late Director-General of Posts and Telegraphs of Austria.

The *Dundee Courier* says that Mr. DAVID SCOTT, a native of Arbroath, has been appointed electrical engineer and adviser to the Bengal Government, with headquarters in Calcutta.

We are officially informed that the second award of the John Fritz Medal has been made to Mr. GEORGE WESTINGHOUSE. This medal was established by the professional associates and friends of John Fritz, of Bethlehem, Pennsylvania, U.S.A., on August 21st, 1902, his 80th birthday, to perpetuate the memory of his achievements in industrial progress. The medal is of gold, of value of about $100, and with it is presented a certificate of the award. The medal was awarded to Mr. Westinghouse for "the invention and development of the air-brake."

We understand that Mr. W. W. BUCKTON, B.A., A.M.I.M.E., A.M.I.E.E., and Mr. H. J. JONES have entered into partnership as consulting engineers, and have taken offices at 72, Victoria Street, S.W. They are devoting themselves more especially to the electrical equipment of collieries, shipyards, ironworks and industrial concerns generally, in which branches of engineering they both have had experience for some years.

Mr. F. W. HARBORD, F.I.C., notifies that, with the consent of the India Office, he has removed from the Royal Indian Engineering College, Cooper's Hill, and has opened a laboratory in London, at 16, Victoria Street, S.W., where he will carry on his private practice, and also, for the present, the analytical work of the Indian Railways.

The Salford Electricity Committee has recommended the T.C. to increase the salary of Mr. H. M. CROSFIELD, chief clerk to the Committee, from £175 to £187 10s. per annum.

The Runcorn Education Committee has appointed Mr. BERNARD MYER as lecturer in electric light and power transmission at the Technical Institute.

Obituary.—We learn from the February *Electrical Contractor* that Mr. GEORGE HILL, a well-known member of the Manchester Branch of the Electrical Contractors' Association, and of the firm of George Hill & Co., electrical and tramway equipment engineers, of Cornbrook, died on December 18th last, at the early age of 38 years. He had been a victim of paralysis for more than six months.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electromobile Co., Ltd. (75,139).—This company's annual return was filed on December 20th, when 35,924 ordinary and 5,000 deferred shares had been taken up out of a nominal capital of £50,000 in 45,000 ordinary and 5,000 deferred shares of £1 each. £1 per share has been called up on 29,000 ordinary shares, resulting in the receipt of £29,000. 6,924 ordinary and 5,000 deferred shares are considered as fully paid. Mortgages and charges: £3,183.

Porous Accumulator Co., Ltd. (57,526).—This company's annual return was filed on January 9th, when the entire capital of £3,000 in £1 shares had been taken up. £1 per share has been called up and paid on 1,007 shares, and 1,993 are considered as fully paid. Mortgages and charges: £16,000.

Ballers, Ltd. (62,020).—This company's annual return was filed on December 30th, when 15,000 ordinary and 15,000 preference shares had been taken up out of a nominal capital of £400,000 in 20,000 ordinary and 20,000 preference shares of £10 each. £10 per share has been called up on seven ordinary and 15,000 preference shares, resulting in the receipt of £150,070. £10,930 is considered as paid on 14,993 ordinary. Mortgages and charges: nil.

Edmundson's Electricity Corporation, Ltd. (52,013).—An acknowledgment of indebtedness dated January 19th, 1906, to secure £100,000 debenture stock (supplemental to a trust deed dated July 10th, 1899, and to six acknowledgments of indebtedness securing in all not more than three-fifths of the paid up capital), has been registered. Property charged: 130 first mortgage debentures of £100 each in the Winchester Electric Light and Power Co., Ltd.; 150 similar debentures in the Wycombe (Borough) Electric Light and Power Co., Ltd.; 200 similar debentures in the Salisbury Electric Light and Supply Co., Ltd.; 150 similar debentures in the Ventnor Electric Light and Power Co., Ltd.; 100 similar debentures in the Bromley (Kent) Electric Light and Power Co., Ltd.; 40 similar debentures in the Woolwich District Electric Light Co., Ltd.; 50 similar debentures in the Chislehurst Electric Supply Co., Ltd.; 40 similar debentures in the Newmarket Electric Light Co., Ltd.; and 50 similar debentures in the Alderley and Wilmslow Electric Supply Co., Ltd., and the company's undertaking and other assets, present and future. Trustees: Sir James Bailey, Kt., Eaton Square, S.W.; and the Anglo-American Debenture Corporation, Ltd., 20, Birchin Lane, E.C. Debenture stock previously issued: £380,000.

Cape Electric Tramways, Ltd. (54,636).—This company's annual return was filed on January 12th, when 491,222 shares had been taken up out of a nominal capital of £500,000 in £1 shares; £91,222 has been received, and £400,000 is considered as paid. Mortgages and charges: £426,800.

Marconi International Marine Communication Co., Ltd. (65,759).—This company's annual return was filed on January 17th, when 250,056 shares had been taken up out of a nominal capital of £350,000 in £1 shares; £1 per share has been called up on 99,056, resulting in the receipt of £99,050 17s. 6d.; £5 2s. 6d. remains in arrears; 105,000 shares are considered as fully paid. Mortgages and charges: £8,000.

Aron Electricity Meter, Ltd. (58,650).—This company's annual return was filed on January 3rd, when 124,896 preference and 125,000 ordinary shares had been taken up out of a nominal capital of £250,000 in £1 shares (125,000 preference and 125,000 ordinary); £1 per share has been called up on the ordinary and £124,948 10s. has been received, including £52 10s. paid on 105 forfeited shares; 125,000 ordinary shares are considered as fully paid. Mortgages and charges: £51,400.

Private Wire and Telephone Installation Co., Ltd. (76,888).—This company's annual return was filed on January 20th, when 1,807 shares had been taken up out of a nominal capital of £3,000 in £1 shares. £7 has been received, and £1,800 is considered as paid. Mortgages and charges: £2,000.

Private Wire and Telephone Installation Co., Ltd., London.—£1,500 5 per cent. debentures, created 4th and dated 6th January, 1906, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees. Holders: Consolidated Electrical Co., Ltd., Broad Street House, E.C., and Mrs. E. L. Russ, West London Hospital.

Power Plant Co., Ltd., London (79,151).—A debenture dated January 8th, 1906, to secure £5,000, charged on the factory and works at Newsley, West Drayton, and the company's undertaking and other assets, present and future, has been registered. Holders: E. M. Hall, Temple Bar House, Fleet Street, E.C., and E. D. Vaisey, 39, Threadneedle Street, E.C.

CITY NOTES.

Anglo-American Telegraph Co.

Mr. F. A. Bevan presided at the general meeting held at Winchester House last Friday. In moving the adoption of the report (see Electrical Review, February 2nd, p. 188), he began by congratulating the shareholders upon a very successful year's working. The gross earnings for the year had been £613,660 against £552,390—an increase of £61,000. That increase was not owing to any particular class of business, but was spread over the whole, and it appeared to be continuing, as they had begun the new year with a considerable increase over the corresponding period of last year. All their cables were in good working order. For the past half-year there was an increase of £14,675 in the traffic receipts, and of £2,863 in the receipts from the *Minia*, and of £196 in interest and transfer fees, making a total increase of £17,735 in receipts over the corresponding period. There was an increase in the working expenses of £497, and there was a sum of £2,330 for Newfoundland taxes. That made an increase of £2,827 to be deducted from the receipts; but, on the other hand, as the renewal fund reached the million before they came to the last quarter, they did not have to set aside the usual £5,000 which they had previously done; and, therefore, deducting that £2,800 from the £5,000, they had £2,200 less spent; adding that to the £17,735 meant a net increase to the shareholders for the half-year of £19,935, but as they had brought forward a less sum by £1,282, there was really £18,652 more to distribute. The dividend that they proposed to give would absorb £21,000 more than last year; they were going to pay 65s. to the ordinary shareholders as against 55s. last year, and the result would be that they would have to take £3,347 from the balance carried forward to make up that £21,000, so that they only had £847 to carry forward; but, looking to the fact that the traffics had begun so well this year, he thought they were acting perfectly safely in so doing. The renewal fund on December 31st, 1904, amounted to £968,927; the interest for the year was £30,946, and they had placed from the revenue £15,000 (for the first three-quarters). They did not require the £5,000 for the last quarter. Thus they would have had a fund of £1,014,873, but they had had to spend upon repairs and cost of cable during the year £13,948, so that the balance was just £925 over a million. It was a very near thing, and he was glad to say that they had at last topped the million. They would hope that, judging from the past, the interest upon that fund would be able to provide for their ordinary repairs and renewals, and still provide a margin which would increase the renewal fund from year to year, in which case they would not require the £20,000 that they had hitherto set aside from revenue. That was a climax which they had long hoped to attain, and they had at last attained; their friends, the Direct United States Cable Co., had also at this period attained to the climax that they aimed at, a renewal fund of £500,000; but their fund was for one cable, whereas the Anglo Co.'s was a million to renew, if necessary, four cables. Therefore they were by no means as well off as their friends, the Direct United. With regard to the repairs, looking back at the history of their cables, it was satisfactory to know that they had had very few deep-sea repairs. Such repairs cost a great deal of money. They had had a good many shallow water repairs, and must expect them, especially now that the trawlers sent their nets down much deeper than they used to do. On several occasions they had broken the cables, and he did not see how this was to be avoided. In regard to the item of £2,330 for taxes in Newfoundland, he told them at the last meeting that the Newfoundland Government proposed to tax the company. This taxation was most unreasonable. The company's original charter from the Government dated from 1854. It gave the company an exclusive right of telegraphic communication in the island for 50 years, and therefore that exclusive right, but only the exclusive right, terminated in 1904. In effect, the charter really did not begin until 1856, because there was no successful cable laid until 1856; therefore it did not take effect until that year, but, in spite of that fact, the Government held the company to the letter of the law, and said that the charter expired in 1904. When 1904 came they thought that they were going to obtain all the company's rights in the island, but they found that they were mistaken. All they could get rid of were the exclusive rights—they could not turn the company out of the island. The company proposed, then, that for a money consideration they should hand over their rights, but they could not come to terms. The Government then promoted a Bill by which they could set up telegraphic communication in the island. They came over here to raise the money to carry that into effect, and to help them to pay interest on the money they raised, they devised a scheme of taxing this company. The speaker went on to refer to what the company had done for Newfoundland—an island which was then disconnected altogether from the mainland, suspended, as it were, in mid-air, was connected both with Europe and America. They put them into close relation with both, and so pleased were they that they were ready not only not to tax the company, but, on the contrary, to help in every way. They made a grant of land; the company had to make a clearance through the island of 600 miles, and the Government helped them in this. After all these years, and after they had done all this, they turned round, and not only taxed the company, but had encouraged their rivals to come, so that there was a rival cable to Newfoundland. They proposed taxation which altogether amounted to £5,000 a year; so that the company were in the position of being taxed by them for the great benefits that they had conferred upon the island. The directors had been in communication with the Colonial Office ever since, but they had not yet got from the Colonial Office what they wanted to obtain from them. Shareholders might be sure that they would use every effort possible to try and get this tax removed. He did not say that it would be easy, or that they would succeed. After briefly referring to the balance-sheet, the chairman paid a tribute to the staff for the admirable way in which they had worked under the extra pressure that the increased traffic had caused, especially at times. They had always risen to the occasion, and on one occasion when there was great pressure, one of their cables in one day carried no fewer than 42,000 words. He believed that the Government Post Office considered that 7,000 words was about the outside a cable ought or might do. The staff all worked with a zeal inspired by the general manager, who night and day lived for, and thought of, nothing but this company. It was from the efficient working of the staff that they derived those increased receipts.

The report was adopted unanimously and its dividends approved, after a question or two regarding the wireless telegraph doings of Marconi, and the old French lawsuit, had been answered. The company were not in the secrets of the Marconi Co., who had been very quiet of late. The French lawsuit decision was, that they were to hand over to this company all their effects—and those effects might possibly be worth £2,000.

The chairman, whose connection as a director of the company dates back over 40 years, was heartily re-elected. Mr. Cunard, a director, and the auditors, were also re-elected, and a vote of thanks closed the meeting.

City and South London Railway Co.

The Rt. Hon. C. B. Stuart-Wortley, K.C., M.P., the newly-appointed chairman, presided at the meeting held at the offices on Tuesday. In moving the adoption of the report (see Electrical Review, February 2nd, p. 189) he said that the special circumstance

under which they were met gave him a special claim upon their indulgence. He referred to the great loss that the death of Mr. C. Grey Mott, their chairman, must mean to the officers and shareholders of the company. He had read the reports of past meetings of the company, and he recognised how his chief study must be to learn how such support was assured to the late chairman and how such confidence was won. He had had but a short time to qualify for the position, and that short time had been made shorter by the fact that it had been made about the time of the general election. In regard to the results of the half-year's working, notwithstanding the adverse influences, such as the weather and the fact that they had had one working day less, they had been able to maintain their dividend in spite of the fact that the additional £150,000 of ordinary stock issued in the June half of last year came in for its full dividend. The line carried 205,000 more passengers and received £221 more; on the other hand, 840 fewer season tickets were issued, representing a decrease of £823. Many holders of season tickets appeared to prefer to take advantage of the 6d. return tickets. The increase in receipts up to December 17th was £593; he took that date because there were two foggy days in that week, resulting in a gain of about £220, but in the week ending December 25th, in 1904, there was a dense fog for nearly the whole of that week, giving to 1904 a fictitious increase of £723. In 1904 Christmas Day was a Sunday, and in 1905 a Monday, so that in 1904 many people had one day less holiday than was usual. Comparing all those pluses and minuses, the net effect was that, comparing one Christmas week with the other, 1905 showed a decrease of £220 against 1904. If normal conditions had prevailed in both years, they would have shown an increase in passenger receipts of about £300. After referring briefly to the increases and decreases in miscellaneous receipts, the chairman said that they were increasing the carrying capacity of their trains, substituting five-coach trains for three or four-coach, which tended to economy. At the present moment, at busy times of the day when they had their maximum number of 24 trains running, 16 were five-coach trains, and they intended in course of time to put the additional fifth coach on the other eight trains. Before giving the statistical results of the half-year, he would remind them that in May last year they made a reduction of fares, and the half-year now under review was the first that had felt the full effect of the reduction. The receipts per train were 15s. 9·7d. against 15s. 8·01d. last year; the receipts per train mile were 2s. 6·9d. against 2s. 6·7d., so that on both items there was a better result. The receipts per passenger had been 1·83d. against 1·86d., a result of which it was difficult to say to exactly what it pointed. The percentage of working expenses was moving in the right direction, it was 46·64 per cent., against 47·22 per cent. The expenses per train-mile were 1s. 3·3d., against 1s. 3·26d. The locomotive charges were 4s. 6·5d., against 4·54d., and the traffic expenses 6·79d., against 6·77d. If they pursued a policy of economising their power by increasing the earning capacity of the power used, some increase in the operating charges must be looked for, compared against the train-mile. In the past half-year they had effected that sort of economy by running about 9,000 train-miles less than in the corresponding half-year, and the number of trains actually run was 89,305, against 90,042. Satisfactory progress had been made with the extension to Euston. He had visited the works and could testify to the way in which the work was proceeding. There had been some little delay in consequence of the engineers finding it necessary to use compressed air between Euston and St. Pancras. Nearly the whole of the important works under Euston Station buildings would be carried out by this method, and the tunnels under the great roof of the St. Pancras Station. This was a requirement in the interests of the safety of these important structures. They had let the contract for the lifts for the extensions to the Otis Co., and were advised that they would have most up-to-date lifts. The chairman then entered into some detail into the very important connections which had been arranged for with various railway companies at Euston and other stations, which ought to be of great value to this company, at all events, in time. It would not do to be too sanguine as to the effect upon their fortunes immediately. All of those great stations had stood up to the present in an isolated position, and this company would be in the position of having first made an important connection between them. A very important connection was with the Baker Street and Waterloo, which was really a Baker Street and Elephant and Castle Railway—a fortunate fact for this company. That railway would be opened at all events as far as Waterloo in about two months, and the extensions to the Elephant and Castle in about four months.

Mr. C. S. GRENFELL seconded the adoption of the report, and after a few observations from shareholders, it was carried.

The meeting passed a resolution cordially endorsing the nomination of the new chairman. The dividend resolution was passed, and the retiring directors and auditors were re-elected. A vote of thanks to the chairman was passed, and also one to the leading members of the staff upon whom, during the illness of the late Mr. Mott, there devolved much important and delicate work, especially connected with the negotiations with other railway companies.

Electric Lighting and Traction Co. of Australia.

THE directors' report to be presented at the annual meeting on Monday, February 12th, shows that during the year ended August 31st, 1905, capital expenditure in Australia on buildings, plant and mains was incurred as follows:—Melbourne undertaking, £7,702; Geelong undertaking, £7,303 = £15,005. The sale of the company's undertakings at Adelaide and Port Adelaide to the Adelaide Electric Supply Co., Ltd., referred to in last year's report, took effect as from September 1st, 1904; the purchase consideration amounting to £162,500, received as to £35,000 in cash and the balance of £127,500 in fully paid ordinary shares of the Adelaide Co., which have been taken into the balance-sheet at par value. The amount of £46,908 13s. appearing in the profit and loss account, represents the balance of the purchase consideration above referred to (after deducting bad debts) over and above the amount at which the Adelaide undertakings stood in this company's books prior to their sale to the Adelaide Co., namely, £115,571. This balance has been applied, as to £30,850 in extinction of suspense account and in writing off the debit balance brought forward from last year, and the surplus of the profit and loss account, amounting to £11,750, which the directors are advised is not available for dividend purposes, has been carried to reserve. The following table indicates the progress made in lighting and power connections at Melbourne and Geelong during the year:—

	Lighting in 8-c.p. lamps.	Motors in rated horse-power	Total expressed in 8-c.p. lamps.
Melbourne—At Aug. 31, 1904 ..	34,452	445 H.P.	48,692
At Aug. 31, 1905 ..	47,854	682 H.P.	69,678
Geelong—At Aug. 31, 1904 ..	10,442	297 H.P.	19,938
At Aug. 31, 1905 ..	14,076	430 H.P.	27,836

Further data, illustrating the growth of the Melbourne undertaking during the past three years, is afforded graphically in the report. The Melbourne undertaking has made excellent progress during the year under review, the result for the period being a gross profit of £6,455, as compared with £3,460 for the previous year. The lamp connections increased during the year by 43 per cent., and as the demand for light and power continues unabated, the directors have decided to order a 1,000-KW. steam turbine generating set for shipment at an early date. The Geelong undertaking is also making steady progress, the gross profit for the year amounting to £1,284, while the lamp connections have increased during the period by 40 per cent. A dividend on the ordinary shares of 1s. 10d. per share recently paid by the Adelaide Co. in respect of the period ended August 31st, 1905, has been taken into this company's profit and loss account. The directors anticipate an increasing revenue from this source in future years.

Liverpool Overhead Railway Co.

THE directors' report for the half-year ended December 31st says that the gross revenue receipts amount to £39,638, and the working expenses to £32,187.

The number of passengers carried during the last two years is as follows:—

	Half-year ending June 30, 1904.	Half-year ending Dec. 31, 1904.	Half-year ending June 30, 1905.	Half-year ending Dec. 31, 1905.
First class	735,223	705,215	673,637	625,430
Third class (including tramways) ..	3,402,444	3,523,985	3,169,953	3,346,930
Workmen (special return tickets) ..	1,486,754	1,384,552	1,714,523	1,645,312
Total	5,624,421	5,613,752	5,558,113	5,617,672

Although the number of passengers carried during the past half-year shows a slight increase—the increase has been entirely in cheap workmen's tickets; there has been a falling-off both in first and in third class traffic.

The directors have introduced a system of differential fares with the view of meeting the competition of the tramways. The average receipts per passenger amount to 1·78d. compared with 1·90d. last year.

The Seaforth extension was opened in July, but the through train service to Southport has not yet been inaugurated owing to the delay in completing the necessary rolling stock by the Lancashire and Yorkshire Railway.

The Seaforth extension has increased the working expenses without so far producing any corresponding increase in earnings.

REVENUE ACCOUNT.

Receipts from passenger traffic amount to	£38,757	7 3
Miscellaneous receipts and interest	881	2 5
	£39,638	9 8
Less working expenses and transfer to renewal funds	32,186	11 7
	£7,451	18 1
Deduct interest on mortgage debentures, and on calls paid in advance	4,328	5 3
	£3,123	12 10
Add balance brought forward, June 30th, 1905 ..	4,336	11 6
Leaving available for dividend	£7,460	4 4

The directors recommend the declaration of a dividend of 5 per cent. per annum on the preference shares (less income-tax), leaving a balance of £3,784 to be carried forward to next half-year.

Central Electric Supply Co.

THE report for the year ended December 31st, 1905, reads:—

Energy has been supplied to the St. James's and Pall Mall Electric Light Co., Ltd., and the Westminster Electric Supply Corporation, Ltd., throughout the year to an amount of 7,102,960 units. The Bill promoted in the last session of Parliament to enable the company to extend the works on the Grove Road site and to lay additional mains for the supply to the distributing companies received the Royal Assent. The company is interested in the present year in the Bill of the West London Electric Undertakers' Association promoted by the Westminster Electric Supply Corporation, Ltd., the St. James's and Pall Mall Electric Light Co., Ltd., the Kensington and Knightsbridge Electric Lighting Co., Ltd., and the Notting Hill Electric Lighting Co., Ltd. After

making a full allowance for sinking fund and depreciation, the net balance for the year 1905 is £291; add balance brought forward from 1904, £7; amount to be carried forward, £298 5s. 3d.

St. James' and Pall Mall Electric Light Co.

The directors' report for the year ending December 31st, 1905, says:—The supply has been distributed from the Carnaby Street and Mason's Yard stations of this company on a total of 286,084 8-c.p. lamps, being an increase of 7,195 in the past 12 months. For this purpose 6,654,217 units were generated at these stations, and 2,385,260 were purchased from the Central Electric Supply Co., Ltd. For the information of the shareholders, a copy of the report and accounts for the past year of the Central Electric Supply Co., Ltd., is enclosed, from which it will be seen that no dividend has been declared in respect of the year 1905. The dividend of £2,500 received last year from the Central Co. has not been carried to the contingency fund of the St. James' and Pall Mall Electric Light Co., Ltd., as had been intended, but has been brought into this year's net revenue account. The directors regret that the profits in the past year's trading do not admit of the payment of a bonus on the ordinary shares, as in previous years. The amount ordinarily available for this purpose has been absorbed by the special charges incurred in defending the company's interests in Parliament, by large temporary disconnections of lamps owing to extensive re-building operations in the district, and by further reduction of the rates for supply rendered necessary by severe competition.

The net profits applicable to dividend on shares for the year 1905 were	£29,744	1 0
Add balance brought forward from 1904	2,891	9 3
	£32,635	10 3
Less interim dividend, paid in August last, for half-year ending June 30th, at rate of 7 per cent. on preference shares, £3,500: 10 per cent. on ordinary shares, £10,000 =	£13,500	0 0
Leaving an amount now to be dealt with of	£19,635	10 3

The directors propose to divide this amount as follows:—

A. By payment of a dividend at the rate of 7 per cent. on the preference shares for the second half-year	£3,500	0 0
B. By payment of a dividend on the ordinary shares for the second half-year of 7s. 6d. per share, making, with the interim dividend paid on August 1st last, a total distribution of 12½ per cent. for the year	15,000	0 0
C. Amount to be carried forward	635	10 3
	£19,135	10 3

Statement of Electricity Generated, Sold, &c., Year ending December 31st, 1905.

Board of Trade units—Generated	6,654,217
Purchased	2,385,260
Quantity utilised—Private supply	7,666,996
Public lighting	148,549
Used on works	162,087
Total	7,977,582
Quantity expended in distribution	1,061,895
Number of lamps on circuit, December 31st, 1905	286,084

Sydney T. Dobson, *Chief Engineer.*

An extraordinary general meeting will be held at the offices after the ordinary meeting on Tuesday, 13th inst., for the purpose of confirming the following resolution passed at the extraordinary meeting held on January 22nd:—

That the Bill introduced into Parliament, intituled "a Bill to Authorise the Association of Electric Supply Undertakers in the West of London, and for other Purposes," a draft of which has been submitted to the meeting, be and the same is hereby approved, subject to such additions, alterations and variations as Parliament or the directors may think fit to make herein.

Companies Struck Off the Register.

The names of the following companies are to be struck off the Register within three months, and the companies will be dissolved, unless cause is shown to the contrary:—

Associated American Electrical Manufacturers, Ltd.
Bee-Bee Electrical Engineering Co., Ltd.
Dynamic Gas Power Co., Ltd.
Harbourne Electrical Manufacturing Co., Ltd.
Industrial Electric Co., Ltd.
Ozone Industrials Syndicate, Ltd.
Paris Singer Electric Carriage Co., Ltd.
Pekin and North China Electrical Corporation, Ltd.

Giant's Causeway Electric Tramway Co.

The meeting of this company was held at Portrush on 29th ult., Mr. Anthony Traill, D.L., presiding.

The directors had again to report a large increase in the receipts for the year, viz., to £3,934 from £3,617 in 1904 and £3,377 in 1903. The number of passengers carried has increased to 128,546 from 119,876 in 1904 and 108,154 in 1903. The net profits on the year's working were £1,783 2s., against £1,479 1s. 9d. in 1904, and £1,241 14s. 8d. in 1903. The number of miles run by electricity had increased to 29,347 from 28,489 in 1904, and 27,954 in 1903. The steam miles had increased from 5,80· to 6,600 during the year. The directors were able owing to this increase in the net profits to still further reduce the outstanding debt against the net revenue which had accumulated during many unprosperous years in the earlier history of the undertaking. That debt, which was £2,702 at the end of 1902, had been reduced in the succeeding years to £2,550 in 1903, £2,156 in 1904, and now to £1,455 at the close of 1905—*i.e.*, a total reduction of £1,247 in three years. Out of the balance of £1,783 2s. the directors had paid 4 per cent. on £13,750 debenture stock and 4 per cent. on the mortgage of £10,000 borrowed for the construction of the Causeway extension, in addition to the large reduction of the old debt above referred to.

The report was adopted.

Dublin United Tramways Co. (1896).—The report for the half-year ended December 31st last states that the amount available for division is £49,707, out of which it is recommended that dividends be paid for the half-year at the rate of 6 per cent. per annum on the preference shares and at the rate of 6 per cent. per annum on the ordinary shares. It is proposed to place £4,000 to reserve fund, £1,000 to accident insurance fund and £2,500 towards maintenance in the current half-year. The dividends recommended and the sums added to reserve, &c., will absorb £42,600, leaving £7,107 to be carried forward. The Bill promoted by the company to transfer the undertakings of the Dublin United Tramways Co. and the Dublin Southern District Tramways Co. to this company received the Royal assent on August 4th last. The old companies were dissolved by the Act, and, in consequence, only one set of accounts is now required.

National Telephone Co.—The directors recommend the following dividends for the half-year ended December 31st last, after payment of the dividends on the preference shares, viz.:—At the rate of 6 per cent. per annum on the preferred stock; at the rate of 5 per cent. annum on the deferred stock, less income-tax, carrying £125,000 to reserve and about £10,000 forward. The dividends are at the same rate as for the corresponding half of 1904.

Great Northern and City Railway Co.—The report for the half-year ended December 31st states that the total revenue receipts amounted to £45,711 as against £36,509 for the corresponding period last year. The number of passengers carried for the same periods, excluding season ticket-holders, were 6,330,661 and 5,227,595 respectively. The number of local season tickets issued during the half-year was 2,663 as against 2,511 for the half-year ended December 31st, 1904. The number of three-route season ticket-holders using the company's line during the past half-year was 2,292.

Kensington and Knightsbridge Electric Lighting Co.—The directors recommend a dividend on the ordinary shares for the half-year ended December 31st at the rate of 10 per cent. per annum, making with the interim dividend paid on August 1st 10 per cent. for the year. It will be observed from our Share List that this compares with a dividend of 12 per cent. for 1904.

Waterloo and City Railway Co.—The report for the half-year ended December 31st states that the gross receipts, less Government duty, amounted to £17,464, and the working expenses to £7,858 during the past half-year, as compared with £17,676 and £7,891 respectively for the corresponding period of 1904. The balance available for dividend, after providing for interest on debenture stock, is £9,155, and a dividend at the rate of 3¼ per cent. per annum on the ordinary stock will absorb £8,775, leaving £380 to be carried forward. This dividend is at the same rate as for the corresponding period of 1904. The London and South-Western Railway Co., who work this railway under a perpetual agreement, have given notice of a Bill to be introduced into Parliament, in which it is proposed to take power to acquire the undertaking upon terms to be agreed between the two companies.

Telegraph Construction and Maintenance Co.—The directors propose to pay a dividend of 10 per cent. (£1 4s. per share) in addition to the 5 per cent. already paid, making 15 per cent. for the year 1905. This is at the same rate as for the year 1904.

Dick, Kerr & Co.—It is stated in the *Manchester Courier* that a proposal was placed before the shareholders at an extraordinary general meeting held in London on 1st inst. as follows:—

1. That each of the 61,000 existing issued preference shares of the company of £5 each, and that each of the 9,000 existing unissued preference shares of the company of £5 each be, and the same is hereby, sub-divided into five preference shares of £1 each.
2. That each of the 52,000 existing issued ordinary shares of the company, and that each of the 8,000 existing unissued ordinary shares of the company of £5 each be, and the same is hereby, sub-divided into five ordinary shares of £1 each.

Prospectuses.—*Canadian General Electric Co.*—There are being offered for sale by Messrs. Sperling & Co. 11,000 shares of $100 each of the Canadian General Electric Co., Ltd., at $142½ per share (£29 5s. 8d.) The company has been in existence since 1891, and all the capital is stated to be now entirely Canadian. The company has in perpetuity the exclusive right to manufacture and sell General Electric apparatus in Canada. The gross business of the Canadian General Electric Co. is reported to have increased very rapidly, and the general belief is that the progress of Canadian industrial development during the next few years will be even more rapid than in the past, owing to the building of the Grand Trunk Pacific Railway, the Canadian Northern Railway, the Extensions of the Canadian Pacific Railway, and the construction of the great electrical power stations at Niagara Falls, and many other important enterprises now under way. The company has over $5,000,000 of work on hand. The subscription list will be closed to-day.

Brazilian Rubber Plantations and Estates, Ltd.—This company also has been offering 145,000 shares of £1 each for subscription. The company is to acquire and work rubber plantations and estates in North Brazil.

The Anglo-Swiss Asbestos Co., Ltd.—This company has been inviting subscriptions (the list closes to-day) for 49,696 preference shares of £1 each.

The Rubber Estates of Johore, Ltd.—Rubber prospectuses are falling thick and fast just now. The latest is issued by this company, which has been inviting applications for 115,000 shares of £1 each, and which is to develop a grant of 25,000 acres of land in Johore for agricultural development and the planting of rubber. The list was to close last Tuesday.

MARKET QUOTATIONS.

Wednesday, February 7th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£35 10	..
a ,, ,,	per ton	£30	..
a Bleaching powder	per ton	£5 10	..
a Bisulphide of Carbon	per ton	£18	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	10½d.	..
a ,, (50 %)	per gal.	10d.	..
a Copper Sulphate	per ton	£24 10	15s. inc.
a Lead, Nitrate	per ton	£25	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90 % at 160° C)	per gal.	5/6	..
a Potassium Bichromate, in casks	per lb.	3d.	..
a Potash, Caustic (75/80 %)	per ton	£20	..
a Potassium Cyanide	per lb.	7½d.	..
a Shellac	per cwt.	200/-	10s. inc.
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	..
a ,, Crystals	per ton	£3 5	..
a Sodium Bichromate, casks	per lb.	2¾d.	..
a ,, Cyanide	per lb.	7d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£160	..
b ,, Wire, in ton lots	per ton	£191	..
b ,, Sheet, in ton lots	per ton	£177	..
b Babbitt's metal ingots	per ton	£43 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	9d.	..
c ,, Tube (brazed)	per lb.	10¾d.	..
c ,, ,, (solid drawn)	per lb.	9¾d.	..
c ,, Wire, basis	per lb.	9d.	..
c Copper Tubes (brazed)	per lb.	11¼d.	..
c ,, ,, (solid drawn)	per lb.	11¾d.	..
g Copper Bars (best selected)	per ton	£93	..
g Copper Sheet	per ton	£93	..
g ,, Rod	per ton	£93	..
c ,, (Electrolytic) Bars	per ton	£92	..
c ,, ,, Sheets	per ton	£104	..
c ,, ,, Rod	per ton	£95	..
c ,, ,, H.C. Wire	per lb.	11d.	..
f Ebonite Rod	per lb.	3/3	..
f ,, Sheet	per lb.	3/-	..
n German Silver Wire	per lb.	1/7	..
h Gutta-percha, fine	per lb.	6/- to 7/-	..
h India-rubber, Para fine	per lb.	5/4½ to 5/5	inc.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	52/2½	11½ dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	..
g Lead, English Ingot	per ton	£16 15	12/6 dec.
g ,, ,, Sheet	per ton	£19	12/6 dec.
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£7 7 6	2/6 inc.
d Mica (in original cases) small	per lb.	6d. to 1/-	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/3	..
p ,, rolled bars & rods	per lb.	1/1½ to 1/3	..
p ,, ,, strip & sheet	per lb.	1/4	..
o Platinum	per oz.	91/6	6s. inc.
e Silicium Bronze Wire	per lb.	11d. to 11½d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£165 to £165 10	30s. to 40s. dec.
n ,, Wire, Nos. 1 to 16	per lb.	1/10½	..
p White Anti-friction Metals— "White Ant" brand	per ton	£46 to £70	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5⅝d.	..
j ,, 3 ply 10 lbs. Russian	per lb.	4½d.	..
j ,, 10 lbs. Russian, single	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£32 5	..

Quotations supplied by:—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, G.P. and Teleg. Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
j Walter H. Hindley & Co., Ltd.
k Morris Ashby, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Co., Ltd.

City of Buenos Ayres Tramways Co. (1904).—The directors recommend the payment of a balance dividend of 1s. 3d. per share for the year ended December 31st, 1905, and that £2,750 be transferred to the general amortisation fund, leaving £82 to be carried forward.

Stock Exchange Notice.—The Committee have ordered the undermentioned security to be quoted in the Official List:—Kalgoorlie Electric Tramways, Ltd.—£100,000 5 per cent. "A" debenture stock and £100,000 6 per cent. "B" debenture stock.

Metropolitan District Railway Co.—The directors announce a dividend on the 4 per cent. guaranteed stock for the past half-year at the rate of 1⅛ per cent. per annum.

STOCKS AND SHARES.

Wednesday afternoon.

Whatever the cause may be, there is no disguising the fact that a distinct hiatus has set in amongst the investment markets. Money continues fairly expensive, but as there is abundance of capital on offer at rates ranging from 4½ to 5½ per cent., it cannot be complained that tightness of money is at the bottom of the prevailing restraint. Some people put down the restraint to the after-effects of the Election, others to the Algeciras Conference, others to uneasiness of investors at the triumph of Labour candidates. But the unpleasant fact remains that Stock Exchange business has not re-awakened, so far this year, to a full extent of its responsibilities towards those who live—or attempt to live—by it.

Only false shame would deny one obvious sequel to lack of business in the Stock Exchange, viz., it renders the task of the scribe so much the more difficult as he surveys the field, now commonplace and uninteresting, to be covered by his efforts—printed in small type.

Electricity supply shares are again a more cheerful topic to discuss than they have been until last week for some time past. There is the usual decline of 5s. to notice in St. James' and Pall Mall shares. But Westminsters are a similar fraction harder at 11¼, and they have recently been amongst the weakest of the weak shares. Smithfield and South London shares have both risen 5s., and the same amount is scored by the Ordinary and the Preference shares of the London Electric Supply Corporation. It is a little singular that these last and low-priced shares should be in request while their heavier brethren remain, in many instances, depressed. Metropolitan Ordinary have also advanced 5s, the movements in shares all being confined to this sum, while of the prior securities only Midland Electric Debenture claims attention by rising a point. Edmundson's new Debenture stock is ½ premium.

We hear that a little syndicate has been formed to experiment with a new incandescent electric lamp which its inventor claims will give better light at a quarter the cost of the lamps now in use. Inventors and fishermen are, of course, only a trifle less modest than journalists, but the syndicate has got so far as to talk of a company being formed to exploit the lamp, with a capital of £100,000.

By the time this paper is in its readers' hands, Central London and City and South London Ordinary stocks will be quoted *ex* their dividends. There was some exchanging of Central London Ordinary for the company's Deferred stock and the latter thereupon improved to 88½, equivalent to 84½ *ex* dividend. But City and South London has again fallen, the hopeful speech of the new chairman at Tuesday's meeting notwithstanding. One of the papers is advocating a purchase of the stock as a good lock-up, an opinion with which we should not quarrel. Metropolitan and Districts are both dull.

Trade in manufacturing circles connected with electricity is said, in the City, to be looking up, and this may have something to do with the rise in Crompton shares to 2⅛, and in Babcock & Wilcox to 4⅛, this latter being a ¼ rise. Whispers are afloat with regard to an increase in the already good Babcock dividend, and there were many buyers in the market on Monday and Tuesday. Dick, Kerr Preference have hardened to 6¼, the Ordinary keeping at 8¾. We have heard nothing to add to our previous information as to the early splitting of the shares. Edison & Swan "A" shares are 2s. 6d. up at 1⅝, but India-Rubbers gave way 10s. to 18½.

Reference was made here last week to the new issue of £150,000 "B" Debentures by the Cape Electric Tramways, and Stock Exchange opinion is somewhat divided as to whether the security deserves attention or not. The luckless company has fallen into such discredit through events fresh in the minds, at any rate, of shareholders, that confidence looks somewhat askance at the new issue. On the other hand, the stock was underwritten by Wernher, Beit & Co. for nothing, and it will pay 5½ per cent. on the money.

Traction varieties are irregular. British Electric Ordinary are ⅛ lower, and London United Preference Debenture stock four points down. There is no need to labour oft-repeated reasons for the weakness now apparent in the London United descriptions. But the Argentine group has advanced, Anglo-Argentine Ordinary ¼, to 9, the Preference $\frac{1}{16}$ to 6 $\frac{1}{16}$ and Belgrano "A" Preference ⅛ to 6. London General Omnibus collapsed to 113 upon a reduction of 2 per cent. in the dividend, due, of course, to motor reasons.

National Telephone Preferred put on ½ at 114, and this was the only change upon the dividend announcement, which came to about what the market had looked for. Chili Telephones are ⅛ firmer at 8⅛. In the Telegraph section, Marconi's have another rise of ⅛ to their credit, making the price 1⅝. The Anglo-American group shows weakness, and Direct United States shares at 15 have lost their rise of last week. Eastern issues call for no remark, and the Trust companies are equally colourless so far as their prices go. A premium of 2½ points is quoted on the new Canadian General Electric shares, now being offered at $142½ per $100 share.

Venezuela.—No change apparently has taken place in the situation as regards the cable dispute with France, excepting that, according to reports, President Castro is busily making preparations for war, and has stated his intention of not being "bluffed." His gunboats no longer run between Trinidad and Amacura.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1902.	1903.	1904.	1905. §	Closing Quotations Jan. 31st.	Closing Quotations Feb. 7th.	Business done week ended Feb. 7th, 1906. Highest	Lowest.	Rise + or Fall —
17,700	African Direct Telegraph, 4 % Debs...	100	4 %	4 %	4 %	4 %	98½—101½	98½—101½	..	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3¾— 4¼	3¾— 4¼	..	..	..
155,600£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	83 — 88	83 — 88	..	..	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	2⅜%	3½%	65 — 67	65 — 67	67	66½	..
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5½%	6 %	114 —115	112½—113½	114½	112½	—1½
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	½%	18¼ — 18½	17⅞ — 18⅛	18⅜	17⅞	— ⅛
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	102 —104	102 —104	103½	103½	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	..	7⅞— 8⅛	8 — 8¼	8¼	8	+ ⅛
1,982,856£	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	97 — 99	97 — 99½	98⅜	97⅞	..
16,090	Cuba Telegraph	10	6¾%	10 %	5 %	5 % §	8¾ - 9	8¾— 9	8¾	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 % §	17 — 18	17 — 18	..	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 % §	3⅜— 3⅝	3⅜— 3⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 % §	8¼ - 8⅞	8¼— 8⅞	..	..	..
30,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	99 —102	99 —102	..	..	..
60,710£	Direct United States Cable	20	3½%	3 %	3½%	3⅝%	15 — 16 xd	14½— 15½ xd	15¼	15	..
70,000	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200,R.	100	4½%	4½%	4½%	4½%	99 —101	99 —101	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	5 % §	148 —151	148 —151	150½	148¾	..
2,000,000	Do. 3½ % Pref. Stock	100	3½%	3½%	3½%	3½% §	91½ — 93½	92 — 94	92⅝	91¼	..
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 % §	107½—109½	109 —109½	108⅝	..	..
300,000	Eastern Extension, Australiasia, and China Tele.	10	7 %	7 %	7 %	6 % §	14½ — 15	14½ — 15	14⅝	14⅜	..
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 % §	107 —109	107 —109	..	..	..
300,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 3,000, red. 1909	100	4 %	4 %	4 %	4 %	101 —103	99 —101 xd	..	..	..
200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	101 —103	101 —103	102⅛	..	..
180,887	Globe Telegraph and Trust	10	£3	5⅔%	5⅔%	5 %	11½— 11⅝xd	11½— 11⅝	11⅝	11½	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14⅜— 14½xd	14½— 14⅝	14⅝	14⅛	..
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	..	37½ — 39½	37½ — 39½	37⅝	..	..
42,300	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	4½%	99 —101	100 —102	..	..	+ 1
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	5 %	57 — 59	57 — 59	57⅞	..	..
251,127	Marconi's Wireless Telegraph	1	..	..	..	..	1 1/16— 1 1/16	1⅛— 1⅛	33/9	31/3	+ ⅛
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	⅞— 1	⅞— 1	18/-	..	..
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	⅞— 1	⅞— 1	18/1½	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	113 —114	113⅛—114½	114½	113⅜	+ ½
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	110 —112	110 —112	111⅜	110⅞	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	13 — 15	13 — 15	..	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	..	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5⅜— 5⅞	5⅜— 5⅞	..	..	..
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	99½—101½	99½—100⅝	100⅜	..	..
1,689,593	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	104 —105	104 —106	105⅛	104½	..
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6¾%	6¾%	6 %	1 7/16— 1 7/16	1 7/16— 1 7/16	27/6	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1⅛— 1⅜	1⅛— 1⅜	25/-	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 — 99	96 — 98	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
11,839£	Reuter's	8	5 %	5 %	5 %	5 % §	7½ — 7⅝	7½ — 7⅝	..	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	102 —105	103 —106	..	..	+1
3,201	Submarine Cables Trust	Certs.	6 %	6 %	6 %	6 %	127 —130	125—128	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	..	7¼ — 7⅜	7¼ — 7⅜	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5⅜ — 5¾	5¾ — 5⅞	5⅞	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	110 —112	110 —112	111⅜	..	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	9½ — 10	9½ — 10	..	..	..
30,008	W. Coast of America, 1 to 30,000 & 53,001 to 53,008	2½	Nil	Nil	Nil	..	1/16— 1⅛	⅛— ⅜	..	..	+ 1/16
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	99½ —101½	100 —102	..	..	..
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930 ..	10	7 %	7 %	7 %	5 %	14¼ - 14⅜	14¼ - 14⅜	14⅜	14¼	..
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	5 %	100 —102	100 —102	..	..	..
563,380	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	102 —104	102 —104	103¼	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅜— ⅝	⅜— ⅝	..	..	..
34,563	Do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	6 %	6 %	8¼— 8⅝	8¼— 8⅝	..	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	..	6½ — 7⅛	6½ — 7⅛	..	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	100 —103	100 —103	..	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

170,000	Anglo-Argentine Trams, 260,008 to 430,007	5	..	..	8 %	6 %§	8⅝— 8⅞	8⅞— 9⅛	9 1/32	8⅞	..
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5¾— 6⅛	5 1/16— 6 1/16	6 1/32	5 1/16	..
266,600	Do. Permanent, 6 % Debs. Stock, 1888	100	..	6 %	6 %	6 %	140 —143	140 —143	142½	..	..
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	104 —106	104 —106	105	..	..
800,000	Babcock & Wilcox, 1 to 530,000	1	..	17 %	20 %	16 %‖	3⅜— 4	4 — 4¼	85/-	82/6	+ ⅛
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1⅞— 2	1⅞— 1 1/16	41/3	..	— ⅛
40,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	3/6	5⅛ — 6	5⅛ — 6	..	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	3/-	5 — 5¼	5 — 5¼	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	..	..	2⅞— 3⅛	3 — 3⅛	6⅝	..	+ ⅛
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	98 —102	98 —102	..	..	..
300,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	..	120 —123	120 —123	121⅜	120½	..
300,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	..	110 —113	110 —113	110⅜	..	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	108 —111	108 —111	..	..	..
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250 ..	40	..	4½%	4½%	4½%	103 —105%	103 —105 %	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	101 —104 xd	101 —104	..	..	..
138,301	British Electric Traction	10	8 %	6 %	6 %	..	8¼— 8⅝	8 — 8½	8¼	8⅛	..
161,437	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %§	10½ — 11	10½ — 11	10 11/32	..	..
1,415,422£	Do. do. 5 % Perp. Deb. Stock	Stock	5 %	5 %	5 %	5 %	119 —121	119 —121	119⅜	..	..
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	98 —100	98 —100	99⅛	99	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %§	7 — 7½	7 — 7½	..	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %§	6 — 6½	5⅞— 6⅛ xd	..	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	103 —106	103 —106	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	98 —100	98 —100	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1⅞— 2⅛	1⅞— 2⅛	41/3	..	..
1,016,353	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	77 — 82	77 — 82	79⅜	79½	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	⅝— ¾	⅝— ¾	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	..	⅞— ⅞	⅞— ⅞	9/9	..	..
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	..	1½— 1⅝	1½— 1¾	31/-	..	..
125,000£	Do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	4½%	99 —101	98 —100	98½	..	—1
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 84	82 — 84	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	..	3⅜— 3⅞	3⅜— 3⅞	75/7½	73/9	..
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	..	5⅞ — 6	5⅞ — 6⅛	6 3/32	5 31/32	+ ⅛
27,500	Do. "B" do. 1 to 27,500	5	..	6 %	6 %	..	5¼ — 5⅝	5¼ — 5⅝	5 11/16	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	105 —107	105 —107	106½	105⅝	+ ⅛
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	101 —104	102 —105	..	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	7 %§	9⅛— 10	9⅛— 10	9 13/16	9 13/16	..
32,610	Do. 105,001 to 137,610	5	..	..	..	3d.	8⅞— 9⅛	9 — 9⅛	9 3/16	9⅛	+ ⅛
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4 %	4½%	104 —106	104 —106	105⅛	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	10%	11 — 12	11 — 12	11⅜	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝— 5¾xd	5⅝— 5¾	..	..	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108 —110	108½—110⅝	..	..	+ ⅛
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 %§	⅞— 1⅛	⅞— 1⅛	18/9	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	..	1 1/16— 1 1/8	1 1/16— 1 1/8	..	..	..
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	97 —102	95 —100 xd	..	..	..
1,999,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	95 — 97	95 — 97	96	95	..
530,316	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %	104 —106	104 —106	..	..	..
530,316	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	86 — 89	87 — 90	89	87⅞	+1
1,480,000	City and South London Railway	Stock	3½%	2⅝%	2½%	1⅞%	43 — 45	41 — 43	42	..	—2
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	2½%	2½%	..	1⅞— 2⅛	2 — 2¼	..	..	+ ⅛
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	95 — 98	96 — 99	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued).*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1902.	1903.	1904.	§1905.	Closing Quotations Jan. 31st.	Closing Quotations Feb. 7th.	Business done week ended Feb. 7th, 1906. Highest	Lowest.	Rise + or Fall—
52,000	Dick, Kerr & Co., 1 to 52,000	† 5	..	..	10 %	..	8½ — 9	8½ — 9	8¾	8½	..
61,000	Do. do. 6 % Cum. Pref., 1 to 61,000	5	..	6 %	6 %	6 %	5¾ — 6¼	6 — 6¼	6 5/32	6¼	+ ⅛
294,150	Do. do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	104 —106	104 —106	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5%	6 %	6 %	13⅞ — 14⅞	13⅝ — 14⅛	..	..	..
59,987	Do. 6 % Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14⅛ — 15⅛	14⅛ — 15⅛	14⅜	..	..
63,400	Do. 4 % Debs.	100	..	4 %	4 %	4 %	99 —101	99 —101	..	..	..
300,000	Do. 3½ % "A" Debs.	100	..	3½%	3½%	3½%	99 —101	98 —100	..	..	..
300,000	Do. 3½ % "B" Deb. Stock	100	..	3½%	3½%	3½%	96 — 98	96 — 98	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £3 pd., 1 to 99,261	5	Nil	Nil	2½%§	..	1⅜ — 1⅝	1⅛ — 1⅜	32/6	..	+ ⅛
17,139	Do. "A" shares, 01—017,139	5	Nil	Nil	2½%§	..	2¼ — 2½	2¼ — 2½	..	..	..
344,023	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	86 — 88	86 — 88	..	..	..
100,000	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	92 — 97	92 — 97	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	..	⅛ — ¼	⅛ — ¼	..	..	..
31,890	Do. do. 7 % Cum. Pref., 1 to 31,890	2	7 %	7 %	7 %	..	2 — 2⅛	1⅞ — 2⅛	42/6	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	90 — 93	89 — 92	..	..	—1
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	9⅛ — 9⅜	9 — 9⅛	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	96 —100	95 — 99	97	..	—1
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %§	5 — 5⅛	5⅛ — 5⅜	5⅛	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10½ — 11½	10½ — 11½	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	102 —103	102 —103	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	10%§	13 — 14	12¾ — 13½	13⅛	..	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	5¼ — 5½	5¼ — 5½	5⅛	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	.. — ..	.. — ..	..	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10 %	5 %	10%	18½ — 19½	18 — 19	18⅛	..	+ ½
800,000	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	12%	1½%	Nil	1⅞ — 2⅛	1⅞ — 2⅛	..	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	6¾ — 7⅛	6½ — 7	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	4 %§	10 — 11	10 — 11	..	..	..
399,930	Do. do. 60,008 to 100,000 (£4 paid)	10	..	8 %	6 %	4 %§	4 — 5	4 — 5	..	..	..
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	8¾ — 9⅛	9⅛ — 9⅜	8⅜	8⅛	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	97 — 100	92 — 97	95	..	—4
314,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	..	3/— — 3/3	3/3 — 3/3	4/3	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	1— — 1 1/16	1 — 1 1/16	20/9	20/3	..
350,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½%	4½%	104—106	104 —106	105½	105	..
20,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	5	..	..	6 %	6 %	5 — 5½	5 — 5⅛	5 7/16	..	..
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	..	8¾ — 9⅛	8¾ — 9⅛	8⅛	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	9¾ — 10⅛	9⅛ — 10⅛	10	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	103 — 106	103 —106	..	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	34½ — 36½	34 — 36	35½	34½	..
150,000	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	98 — 99	98 — 99	..	..	..
540,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3½%§	96 — 99	97 —100	..	..	+1
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	8½%	6 %§	..	..	2 — 2⅜	2 — 2⅛	..	..	..
66,666	Do. 6 % C. P., 80,001 to 80,000 & 125,001 to 141,666	5	..	6 %	..	..	4 — 4⅛	4 — 4⅛	82/6	81/3	..
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	82 — 87	82 — 87	..	..	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5½%	4 %§	5½ — 5⅝	5½ — 5⅝	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%	102 —105	102 —105	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	9 %	8½ — 9⅛	8½ — 9⅛	8⅝	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	8½ — 9⅛	8½ — 9⅛	..	..	..
300,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	102 —105	102 —105	103	102½	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %§	5⅞ — 6⅛	5⅞ — 6⅛	6	5⅞	..
80,000	Do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	5¼ — 5⅜	5¼ — 5⅜	5 7/16	5 5/16	..
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	4⅜ — 4⅝	4⅜ — 4⅝	..	..	..
40,000	Do. do. 1903	5	..	4½%	4½%	4½%	4⅜ — 4⅝	4⅜ — 4⅝	..	..	..
120,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —103	101 —103	102⅔	102½	..
44,428	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	4½%§	5 — 6	5 — 6	5 11/16	5½	..
175,000	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108 —110	108 —110	108	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	5 %	11 — 12	11 — 12	11⅜	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	13½ — 14½	13½ — 14½	13⅝	13⅜	..
400,000	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	122 —126	122 —126	..	..	..
300,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	102	..	..
40,000	County of Durham Electrical Power, Ord.	2	..	..	..	..	1⅞ — 2⅛	1 15/16 — 2 1/16	..	..	..
50,000	Do. do. do. 5 % Pref.	5	..	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	5 5/16	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	4 %§	8¾ — 9⅛	8⅝ — 9⅜	9	..	..
80,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	12⅝ — 13	12⅜ — 13	12 13/16	12⅝	..
400,000	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	109 —112	109 —112	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	101 —103	101 —103	..	..	..
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	5 %§	4⅜ — 5½	5 — 5⅛	99/6	95/-	..
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	6 %	6 %	5⅜ — 5⅝	5 — 5⅛	5 5/16	5 1/16	..
320,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	104 —106	104 —106	105½	104⅞	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	4 %§	5¼ — 5⅜	5¼ — 5⅜	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	5 — 5½	5 — 5½	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	101 —104 xd	102 —105	..	..	..
13,000	Hove, 1 to 13,000	5	..	8½%	8½%	8 %	8¼ — 8⅜	8¼ — 8⅜	..	..	..
10,000	Do. New (£5 10s. paid)	£3	..	8½%	8½%	8 %	7⅜ — 8¼	7⅜ — 8¼	..	..	..
37,300	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —101	98 —101	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	98 —101	98 —101	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12%	12 %	10 %	10½ — 11½	10½ — 11½	..	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	98 —101 xd	98 —101	..	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	..	1⅜ — 2⅛	2 — 2⅛	41/3	..	+ ⅛
60,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	4⅜ — 5⅛	5 — 5⅛	..	..	+ ¼
374,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10 %§	8¾ — 9⅜	9 — 10	9⅜	9¼	+ ⅛
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	4½%	5¼ — 5⅜	5¼ — 5⅜	5 1/16	5⅛	..
220,000	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	107 —111	107 —111	..	..	..
250,000	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	100 —102	101 —103 %	102	..	+1
57,009	Newcastle-on-Tyne, 1 to 57,009	5	..	8 %	8 %	2½%§	8 — 8¼	8 — 8¼	..	..	..
17,991	Do. 57,010 to 75,000	5	..	..	..	2/4½	8 — 8¼	8 — 8¼	..	..	..
57,009	Do. 5 % Pref., 1 to 57,009	5	..	5%	5	5 %	6½ — 6⅝	6½ — 6⅝	..	..	..
17,991	Do. 57,010 to 75,000	5	..	..	..	2/4½	6½ — 6⅝	6½ — 6⅝	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	6 %	13½ — 14½	13½ — 14½	..	..	..
64,000	Do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	98 —100	98 —100	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	5 %§	6⅝ — 6⅞	6⅝ — 6⅞	..	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	99 —101	99 —101	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	11¼ — 12¼	11 — 12	..	..	— ¼
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8	..	..	..
150,000	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	97 — 99	97 — 99	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	2 — 2¼	2¼ — 2⅜	..	..	+ ⅛
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	76 — 80	76 — 80	..	..	..
65,000	South London Electricity Supply, Ord.	5	12½%	3 %	4 %	..	3 — 3¼	3⅛ — 3⅜	70/-	66/3	+ ⅛
103,700	South Met. Elec. Lt. & Power (Ord.	1	Nil	Nil	Nil	..	⅜ — ⅝	⅜ — ⅝	..	..	..
85,368	*(Late Blackheath and Greenwich* 7 % Pref.	1	Nil	7 %	7 %	7 %	1 1/16 — 1 1/8	1 1/16 — 1 1/8	..	..	..
148,292	*Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	105 —108	105 —108	..	..	..
50,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	4⅝ — 4⅞	4⅝ — 4⅞	..	..	..
30,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5 — 5½	5 — 5½	5 1/16	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	104 —106	104 —106	105⅛	105	..
110,000	Westminster Electric Supply, Ord.	5	12 %	13½%	14 %	13 %	10¾ — 11½	10⅞ — 11⅜	11⅜	11	+ ⅛
28,151	Do do. 4½ % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅜ — 5⅝	5⅜ — 5⅝	..	..	..

Shares not officially quoted :—Mackay Companies, ord., 60—61½. Pref. 74½—75.

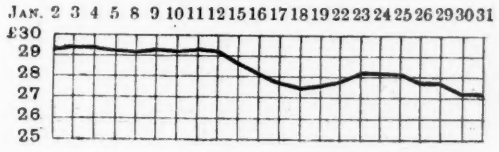
† Unless otherwise stated all shares are fully paid. § Interim dividends.

Bank rate of discount 4 per cent. (September 28th. 1905).

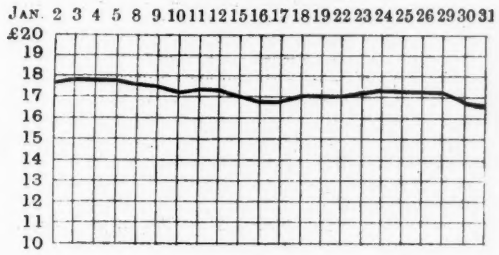
METAL MARKET.

Fluctuations in January.

SPELTER (G.O.B's.)



LEAD (ENGLISH



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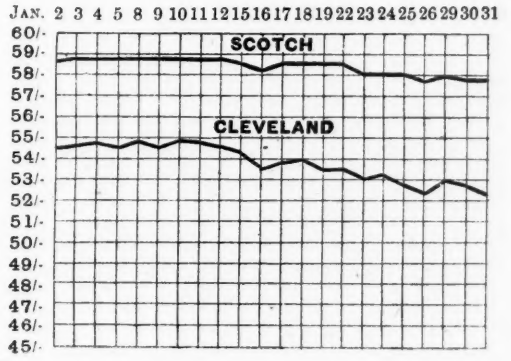

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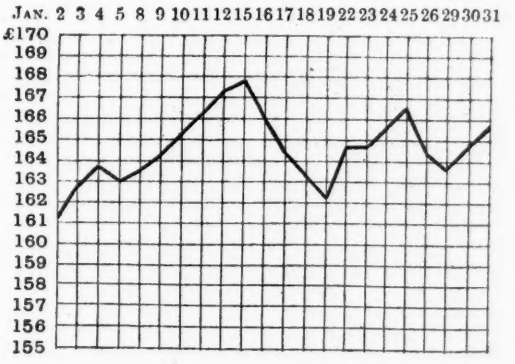
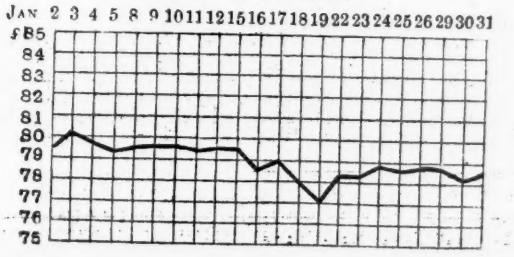


COPPER (G.M.B's.)



EXPERIENCE IN THE ELECTRIC LIGHTING OF TRAINS IN INDIA.*

Mr. Shadbolt, the Director of Railway Construction in India, has reported upon the Stone train lighting system as used on the Jodhpur-Bikanir Railway, and upon the independent storage battery system as used on the Rajputana-Malwa Railway. Mr. Shadbolt's communication bears the date of September 25th last.

The Indian Railway Returns for 1904 enumerate the number of coaches fitted for lighting with electricity, some 485 of these being distributed as follows:—Rajputana-Malwa Railway, 238; South Indian Railway, 95; Kalka-Simla Railway, 92; Johdpur-Bikanir Railway, 44; Burma Railway, 19; Great Indian Peninsula and Indian Midland Railway (jointly), 3; and the Bengal-Nagpur, Bombay, Baroda and Central India, and Eastern Bengal State Railways, 1 each.

The Jodhpur-Bikanir Railway lighting system is not the Stone system in its usual English form, where each vehicle is an independent unit, but a modification required by the metre gauge of the line. A dynamo and set of accumulators are fitted to each van only, fore and aft of the brake of the passenger coaches, all of which are wired and connected through flexible couplings. By limiting the number of dynamos to two per train, the destruction of the belts from the action of the compensating slip on the pulley has proved a serious item in the maintenance of these installations, amounting to 9 per cent. of the annual cost of working. With trains fitted with 46 5-c.p. lamps each, the cost of lighting three trains for 12 months amounted to Rs. 2,715-13-0, of which nearly one-half was occasioned by the expenditure of Rs. 1,365 odd for the inspection and running staff; an inspector was also carried on each train to superintend the lighting, and the sum of Rs. 502 odd was expended for re-charging accumulators and replacing parts thereof.

Our contemporary says:—As compared with the pamphlets circulated by Messrs. Stone & Co., which state that in English practice inspection need only be made after six months, "oiling after 14 to 20 days, and re-charging and cleaning accumulators after 15 to 16 months," the Jodhpur-Bikanir practice, based on 12 months' working, involves the oiling of the main oil-box of the dynamo once a week, and of the rocking arm every day, while accumulators are tested and the specific gravity adjusted every month, and a complete overhauling of the dynamo, and cleaning and re-charging of the accumulators every six months.

The other system described in the memorandum is the independent storage battery system in use on the Rajputana-Malwa Railway. This involves the carrying on the coaches of a number of independent batteries which when discharged are taken out and re-charged.

Mr. A. T. Houldcroft, of the Rajputana-Malwa line, reports that hermetically sealed batteries failed to give satisfaction in regard to ascertaining the specific gravity and volume of the electrolyte, and the difficulty of ascertaining the condition of the cell, while the compound used for sealing the cells left a thick deposit at the bottom of the cell, and in some cases caused short-circuiting. An open type cell, with a removable vulcanite lid, was therefore adopted. Other difficulties were those due to vibration, resulting in the breaking of the lugs of the positive plates; in a very few cases the paste in the negative plate has fallen out, while in others deliberate malice manifested itself by filling the boxes with filth and nitric acid. The system has, however, given every satisfaction, and the company has effected savings in the cost of train lighting, a considerably improved light being secured at a little over half the cost of oil.

SELENIUM AND ITS USES.

The element selenium, which is destined to play so important a part in wireless telephony, has recently been the subject of experiments at the hands of MM. Aichi and Tanakadate, at Tokio, who found that by heating up the selenium to a temperature of 220° C., and then cooling it, they obtained a curve of variation of electrical resistance which did not pass through the origin, and that they could obtain increased conductivity, and a positive temperature coefficient over a large range of temperature, the variation of conductivity being apparently due to a modification of molecular structure.

Selenium was used in 1875 by Werner Siemens in the construction of a selenium photometer, but at that time the metal could only be prepared to be sensitive to the red, orange and yellow rays; recently, however, selenium has been prepared in such a manner that it is extremely sensitive to both radium and Röntgen radiations.

M. Ruhmer, in *L'Eclairage Electrique*, October 14th, 1905, describes a photometer and radiometer for Röntgen rays, in which he makes use of selenium specially prepared for this purpose.

The selenium element is placed in series with a battery and a milliammeter, the reading of which increases or decreases in a manner exactly analogous to the intensity of the photographic and therapeutic effects. This Röntgen radiometer is the first measuring apparatus which permits of an exact dose of Röntgen rays being given, except by inference, in therapeutic applications.

* *Indian Engineering.*

The effect of light upon the conductivity of selenium has been employed by M. Julius Pintsch in the automatic lighting of gas buoys, and the general arrangement of such an apparatus is diagrammatically shown in fig. 1, where *d* is the selenium element placed in series with a battery and a relay, the armature of which takes up the position *b* or *c*, depending upon the amount of light falling upon the selenium; the battery current from *f* then passes by way of *b* or *c* through one or other of the two solenoids, thus actuating the cock *k*, opening it to light up the buoy at dusk or closing it to extinguish the lamp during daylight.

The consumption of current by the selenium element is so small, that the smallest dry cells will readily last for 12 months; the relay battery *f* is specially constructed to withstand shocks. Such an apparatus has been in uninterrupted use for a considerable time without giving the least trouble.

In Bell's first photophone the solar rays were projected by a mirror on to the silvered membrane of a special speaking trumpet, and thence reflected to the receiving station; as the vibrating membrane is sometimes concave, sometimes convex, the rays are rendered convergent or divergent, and are concentrated on a selenium element placed at the focus of a parabolic mirror at the receiving station, and in series with a telephone. In 1880 Bell and Tainter

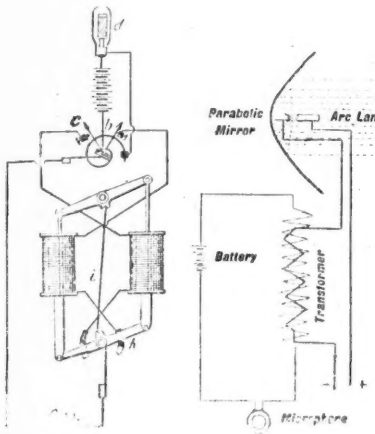


Fig. 1.

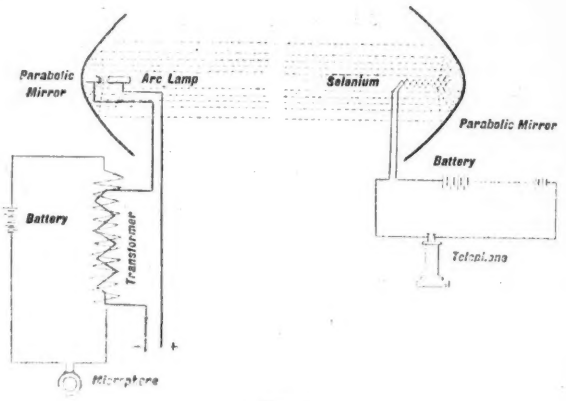


Fig. 2.

succeeded in talking over a distance of 200 metres by this method, but using the rays of an arc lamp for the purpose.

Now M. Ruhmer has been able to telephone without wires, with perfect success, over a distance of 15,000 metres, making use of apparatus illustrated diagrammatically in fig. 2.

A microphone is connected in series with a battery and the secondary of a transformer, the primary of the transformer being arranged in series with a direct-current arc placed at the focus of a parabolic mirror; at the receiving end a selenium element is arranged at the focus of another parabolic mirror, and is connected in series with a battery and a telephone.

Variations of intensity of radiation are produced in the arc exactly corresponding with the words spoken into the microphone, and these varying radiations acting upon the selenium reproduce the words in the telephone.

M. Ruhmer, using a 60-cm. searchlight, has recently held communication between Berlin and a clock tower on the Falkenberg, using this apparatus, manufactured for the purpose by the Schuckert Co.

In spite of the absorption of light in transmission, of dispersion, and the fact that the perfectly polished parabolic receiving mirror received only the 100 millionth part of the light from the transmitter, the words spoken into the microphone at Berlin were heard, clear and distinct, in the telephone at the receiving end.

As a larger receiving mirror would gather more rays, it is certain that this method could be operated over much greater distances, such being only limited by the curvature of the earth, since with this method, as distinguished from wireless telegraphy, the two stations must be reciprocally visible.

The results obtained show that the method is of considerable practical importance, and has a distinct sphere of usefulness in naval work, possessing several advantages over wireless telegraphy.

M. Ruhmer has also achieved success in telephoning in both directions, and will publish at a later date the results of his work in this direction.

THE GERMAN ELECTRICAL INDUSTRY.

The Year 1905 a Period of Prosperity.

The practical freedom from electrical promotions which obtained in 1904, extended to 1905, which was a year of progress and considerable industrial activity in all branches owing to the large demand experienced both in Germany and abroad. Notwithstanding increases in the number of workmen and the introduction of overtime and night shifts, a scarcity of skilled workers was noticeable in the heavy departments incidental to the construction of dynamos, motors and transformers. In the cable branch also, and particularly lead cables, the degree of employment was considerable, the export market showing special signs of development.

The exports of cables to Russia and to Central and South America were considerably greater than in 1904, and Holland also became a larger market for cables. The orders increased so much that the number of workmen was inadequate for the purpose of completing the cables as speedily as was necessary, and higher wages had to be paid in many cases. The principal exports in 1905 were as follows, as compared with the previous year:—

	1905.	1904.
Electrical machinery	12,786 tons	12,164 tons
Accumulators	2,841 „	2,576 „
Cables	28,773 „	19,028 „
Telegraph and telephone apparatus, &c.	604 „	574 „

The shareholders in the Allgemeine Elektricitäts Gesellschaft, whose financial results for 1904-5 were briefly referred to in this journal on December 1st, 1905, approved the accounts at the recent general meeting, although some of them urged the payment of a higher dividend than the rate of 10 per cent., which was eventually passed. The gross profits amounted to £616,576, and the net profits to £547,733, these comparing with £521,935 and £428,331 respectively in 1903-4. As in former years, the sum provided for depreciation — £22,990, as against £28,823 in 1903-4—is inconsiderable, as the new machinery and equipment have again been written off out of the profits, and thus the machinery and tools are completely written off in regard to the machine works, the apparatus department, the glow lamp factory and the cable works. The report of the directors states that a satisfactory increase in the turnover and orders took place in every branch, and the favourable results might have been influenced by the preparations of various industries in anticipation of the new commercial treaties, the effects of which the German electrical industry would have to reckon with. The development of steam turbines for land and marine purposes was successful, and the technical and economical preliminaries for the introduction of electric and high speed railways appeared to be now fulfilled, although the experience now being gained would have an important bearing upon the actual adoption of electric traction. As to the ramifications of the company, the report mentioned that the organisation embodied 32 companies with 62 bureaux abroad, as well as 26 installation bureaux and 17 engineering departments in Germany, whilst 29 agencies were maintained in countries outside of Europe. Owing to the import duties, the company had been compelled to take up manufacturing in Russia, and for that purpose the Russian subsidiary company increased its capital and acquired the works at Riga from the Union Electricity Co. At the date of the report the company had in its employ a total of 30,366 workpeople as compared with 27,487 at the corresponding period of the previous year. The machine works, where 7,252 persons were engaged, delivered 25,829 dynamos and 1,962 transformers of a total of 476,761 kw. during the year, being an increase of 68 per cent. in the output in kw.; the apparatus factory afforded employment to 6,405 persons, the turbine works to 1,568, the cable works to 5,634, and the motor-car works to 663 workers. The Nernst lamp was improved, and the simplification of the burner had allowed of a considerable reduction in the price of the lamp. All branches of industry provided the company with orders during the year, including the ironworks for driving auxiliary machinery, the coal mines, and the paper and textile trades; and considerable activity was manifested in central stations and tramways. The capital of the company is now being increased to £5,000,000.

The Siemens-Schuckert Works Co., which will be remembered as an amalgamation of the heavy electrical engineering departments of the Siemens & Halske Co. and the Schuckert Co., is only responsible to these two companies, and therefore reports directly to them in regard to the business transacted each year. In these circumstances it is necessary to turn to the reports of one of the two proprietary companies for information. Taking the Schuckert Co., for instance, we find appended to the company's annual statement a separate report dealing with the Siemens-Schuckert Works for 1904-5. This report states that the working results fully realised expectations, and rendered possible the distribution of satisfactory profits to the proprietors, after having made provision for depreciation to the extent of £108,680; but the amount of the profits is not disclosed in the report. During the year the large demand compelled the company to increase the working plant, and the sales organisation was also extended. The orders received for generators, motors and transformers represented 421,862 kw., apart from 14,000 motors of low powers. In addition to making further progress in regard to installations in mines and ironworks, the company carried out many new central stations and extensions of old works. The question of stations for long-distance transmission had led to the elaboration of new schemes. The 35,000-volt transmission plant ordered in the previous year had been set in operation with success, and fresh proposals with pressures up to

50,000 volts were partly in preparation and partly being executed. A large demand was experienced for steam turbines, and the experience gained with the Zoelly turbine had fulfilled expectations. The company was considerably interested in the conversion of the Hamburg-Altona Railway to electric traction, and the single-phase system had proved its advantages. The report briefly mentioned the labour troubles which occurred at Munich in the spring, and at Berlin later in the year. The share capital stands at £4,500,000, of which £500,000 had not been called up during the year. The Siemens & Halske Co. holds £2,502,500 of the share capital, and the Schuckert Co., the sum of £1,997,500. It is now proposed to call the remaining £500,000 in order to enable the company to deal with the numerous orders which have been received recently.

The accounts of the Siemens & Halske Co. for 1904-5, which were approved without discussion at the recent general meeting, show that the company has had another satisfactory year indicating improvement over the previous 12 months. Given in one total, the gross profits amounted to £451,077, as compared with £370,500 in 1903-4. The general situation is as follows:—

	1904-5.	1903-4.
Share capital	£2,725,000	£2,725,000
Loan „	1,413,000	1,430,000
Net profits	293,381	220,167
Depreciation	61,969	53,431
Dividend, per cent.	9	7
Carried forward...	51,340	56,057

It is important to note that the net profits have been arrived at after having written off the sum mentioned for depreciation. The profits realised from the company's share in the Siemens-Schuckert Works Co. are not specifically enumerated. The directors' report states that the manufacturing business developed satisfactorily, and the orders received were about one-third greater than in 1903-4. The transfer of the light electrical engineering department to the new works on the Nonnendamm was completed in the spring of 1905, and the greater portion of manufacturing is now carried on there. After a reference to the development in telephone apparatus, fire alarm signals and measuring instruments, the report pointed out that a number of railways in Germany and abroad had adopted the company's switch and signalling appliances. The new Tantalum lamp, after reaching a daily production of 1,000 lamps, was brought under public notice, and both manufacture and sale had made satisfactory progress. As far as electric railways are concerned, the extension of the Berlin underground line from the Knie to the Wilhelmsplatz was to be opened in 1906, and the negotiations for a prolongation of the railway into the inner portion of Berlin seemed to be approaching a conclusion. In conjunction with the Allgemeine Elektricitäts Gesellschaft, the company had entered into an agreement with the City of Hamburg for the construction of a city and suburban railway at an estimated cost of £2,050,000, and the contract had been approved in principle by the citizens. The report mentioned the late labour troubles, which arose, it appears, for the first time in the history of the firm, and which led to the temporary closing of the works. The balance-sheet shows that the company is interested in the Siemens-Schuckert Works Co. to the extent of £2,500,000, in the Austrian Siemens-Schuckert Works Co. for £450,000, and for over £500,000 in various subsidiary companies. It was stated at the general meeting that the works were well employed, and satisfactory results were also expected for the present financial year.

The Schuckert Co. (Elektrizitäts Actien Gesellschaft vorm. Schuckert & Co.) has again declared a dividend, this being the first occasion of profit distribution for a period of several years. At the recent meeting, certain shareholders desired to be informed of the amount of profits received from the company's investment in the Siemens-Schuckert works, but no information on the subject was placed before them. The main financial features of the Schuckert Co. are given below:—

	1904-5.	1903-4.
Share capital	£2,100,000	£2,100,000
Bonds	1,460,000	1,535,000
Net profits	73,622	63,373
Dividend, per cent.	4	Nil.

The surplus available for disposal becomes increased to £133,827 by reason of the balance brought forward from 1903-4, and after providing for the payment of the 4 per cent. dividend, there remains £46,146 to be carried to the next account. The directors' report states that the Siemens-Schuckert works yielded satisfactory results, and the company's other investments and participations also in the majority of cases realised larger surpluses. The company holds £1,441,000 of the share capital of the Nuremberg Continental Co., which is entered at one-half of its nominal value. At the Schuckert meeting it was suggested that the share capital of the Continental Co. should be reduced. The directors replied that attention had already been given to the question, but that an opportune time for the scheme to be undertaken had not yet arrived.

The Elektrische Licht und Kraft Anlagen Gesellschaft (Electric Light and Power Investment Co.), of Berlin, has declared a dividend for 1904-5 at the rate of 7 per cent. on a share capital of £937,500, as contrasted with 5 per cent. on the same amount of ordinary capital in the preceding year. According to the accounts, which show the profits in a single total, the gross revenue from shares, syndicate participations and interest reached £131,850, as compared with £96,347 in 1903-4, and the net profits were £85,104, and £61,016 respectively. The company's loan capital is £875,000, and the interest payments absorbed £39,375. In addition to numerous German undertakings, the company is also interested in many lighting and power enterprises in different parts of the world. A loan of £60,000 advanced to an English firm still stands in the books, and the sum of £15,000 represents the company's holding in the Underground Electric Railways Co. of London.

PROCEEDINGS OF INSTITUTIONS.

The Measurement of High Frequency Currents and Electric Waves.

By Prof. J. A. Fleming, M.A., D.Sc., F.R.S.

(*Abstract of Cantor Lectures delivered before the* Society of Arts; *continued from page* 194.)

Measurement of Frequency and Resonance.

We have seen that every electrical circuit containing a condenser and inductance when charged and discharged executes electrical oscillations with a certain definite period depending on the capacity and inductance. The circuit may, therefore, be compared to a pendulum which has a periodic time depending on its length. Suppose that we have two such oscillatory circuits placed near to each other in the right position, oscillations set up in one circuit will induce oscillations in the other circuit, and the circuits are said to be inductively coupled. They exercise a mutual action and reaction, and may be compared to two pendulums coupled together mechanically.

Let us suppose that we take a trace of the motion of the bob of each pendulum, by causing it to mark its vibrations on a strip of paper which is moved uniformly across its motion. We should obtain a curve for each, waxing and waning as the amplitude of the pendulum motion increased and decreased.

It is a well known fact that such a curve is the resultant of two simple harmonic motions of slightly different period, and it is the graphic representation of the audible effect called beats in music, due to the simultaneous action of two sources of sound, say, two organ pipes slightly out of tune with each other. Hence, we may resolve the waxing and waning motion of each of the coupled pendulums into the sum of two simple harmonic motions of different period. The same thing holds good in the case of two electric oscillatory circuits, or a pair of coupled circuits, constituting an oscillation transformer. These are said to be closely or loosely coupled, according as their mutual induction is large or small, the coefficient of coupling denoted by the letter k being equal to $M/\sqrt{L\,N}$, where M is the mutual inductance of the two circuits, and L and N are the inductances of the two separate circuits.

If we introduce into the secondary circuit a hot-wire ammeter, and measure the effective value of the current in the secondary circuit, we find that in proportion as the secondary circuit is brought into tune with the primary circuit, so does this secondary current increase up to a maximum value, which is called the resonance value. We can plot a curve called a resonance curve, ordinates of which represent the ratio of the maximum or resonance current to any other current, and corresponding abscissæ represent the ratio of the natural frequencies of the two circuits (see fig. 11). The form of this resonance curve will depend upon the nature of the coupling. If the coupling is very weak, then the resonance curve has one maximum value. If the coupling is stronger, then it has two maxima like the hump of a dromedary camel. When the tuning of the two circuits is not quite exact, theory shows that there are two sets of super-imposed oscillations in the circuit. The resultant oscillation is the sum of these two. When the two circuits are not strongly coupled and are tuned to the same period n_0, then it can be shown that the frequencies n_1 and n_2 of the two resultant oscillations in the secondary circuit are given by the formulæ:—

$$n_1 = n_0 \frac{1}{\sqrt{1-k}},$$

$$n_2 = n_0 \frac{1}{\sqrt{1+k}},$$

where $k = M/\sqrt{L\,N}$,

and accordingly we have—

$$n_1^2 + n_2^2 = 2\,n_0^2,$$

$$k = \frac{n_1^2 + n_2^2}{n_1^2 - n_2^2}.$$

To illustrate and investigate these facts I have devised an instrument called the cymometer, which has proved itself to be exceedingly useful in connection with high frequency measurements. The principle on which this cymometer is constructed is as follows:—

It consists (see fig. 12) of a sliding tubular condenser, formed of two brass tubes separated by an ebonite tube. The outer tube can be moved by a handle h, and an index pointer P moves with it over a divided scale S S. Parallel with the condenser is an inductance coil H H, consisting of bare copper wire, wound on an ebonite tube. From the outer tube of the condenser O, a pin l, having a crutch end, lies on the inductance, and the circuit is completed by a copper bar L_1 L_2, of square section. With the instrument is supplied a vacuum tube V, which is attached to two small hooks placed on the ends of copper wires, which are respectively in connection with the outer and inner tubes of the

condenser. The special characteristic of this instrument is that its inductance and capacity are varied simultaneously and in the same proportion by one movement of a handle.

One vacuum tube consisting of a tube of uranium glass filled with rarefied carbon dioxide is supplied with the instrument, but, by special arrangement, a tube filled with the rare gas neon, can be supplied. The neon vacuum tube, as I have shown, is far more sensitive than any other form of vacuum tube, and its glow is so brilliant that it can be seen in a large room in broad daylight.

The instrument is employed in the following manner:—

1. *To Determine the Frequency of the Electric Oscillations in any Circuit.*—Place the cymometer so that the copper bar L_2 L_3 is parallel with, and close to, any straight portion of the circuit in which electric oscillations are taking place. Then fix the vacuum tube to the two small hooks in connection with the terminals connected to the inner and outer brass tubes forming the condenser, and screw the ebonite handle into the thick collar k of the outer tube of the sliding condenser. Move the handle, thus sliding the outer tube of the condenser along, until the vacuum tube glows most brightly. Then the end of the index P will indicate on the lowest of the four scales the number of oscillations in one-millionth of a second. Thus, suppose it reads 3·5. This indicates that the frequency of the oscillations is 3·5 millions. Also the top scale reading indicates the *oscillation constant* of the circuit being tested, viz., the square root of the product of the capacity in microfarads and inductance in centimetres of the cymometer circuit in the position in which it is at that instant, and therefore of any other circuit which is loosely coupled and in resonance with it. If, then, we know either the inductance or the capacity of that circuit, we can determine the second quantity. The range of the oscillation constant for the instrument illustrated is from 0 to 12. The frequency of the oscillations is connected with the oscillation constant by the rule: frequency = $5{\cdot}033 \times 10^6$ divided by the oscillation constant. Hence the product of the oscillation constant as recorded on the scale, and the number of oscillations in one-millionth of a second, is almost exactly equal to the number 5.

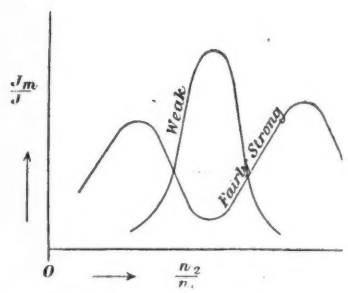


Fig. 11.—Resonance Curves.

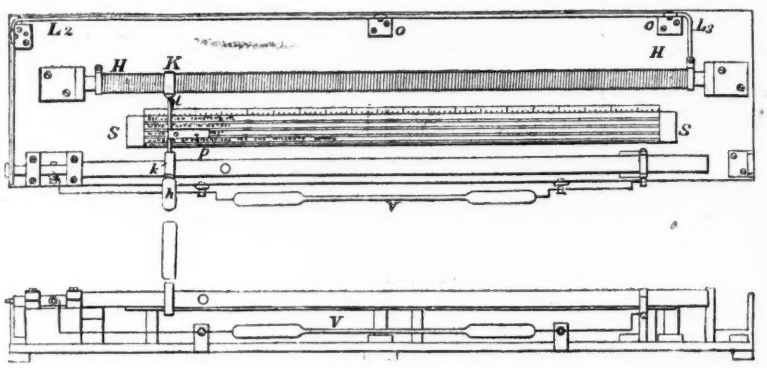


Fig. 12.—The Cymometer.

A variety of other measurements can be made with the cymometer, which will suggest themselves if it is remembered that when the cymometer bar is placed parallel and near to any circuit in which oscillations are taking place, and which has, therefore, capacity and inductance, the scale reading when the vacuum tube glows most brightly, taken on the scale marked "oscillation constant," gives the square root of the product of the capacity reckoned in microfarads, and the inductance reckoned in centimetres of the circuit being tested.

In the previous courses of lectures I have explained the mode in which the oscillations in an antenna throw off electric waves of definite wave length. The relation between the wave length λ of the radiated wave measured in centimetres, and the frequency n, is given by the formula—

$$3 \times 10^{10} = n\,\lambda.$$

Hence, since the frequency itself is expressed by the formula—

$$n = \frac{5 \times 10^6}{\sqrt{C\,L}} = \frac{5 \times 10^6}{O},$$

where O is the oscillation constant = $\sqrt{C\,L}$. Accordingly we can determine the length of the radiated wave when we know the oscillation constant of the antenna. This can be at once determined by placing the cymometer near to it, and moving the handle of the cymometer so as to adjust its capacity and inductance until the neon tube shines most brightly. When this is the case, the scale reading of the cymometer shows its oscillation constant, and therefore also that of the antenna. The wave length of the radiated wave is therefore given by the following formulæ—

$$\lambda = \frac{3 \times 10^{10}}{n},$$

$$n = \frac{5 \times 10^6}{O},$$

$$\therefore \lambda = \tfrac{3}{5}\,10^4\,O,$$

$$\text{or} \quad \lambda = 6{,}000 \times O \text{ cm.},$$

$$= 60 \times O \text{ metres},$$

$$= 200 \times O \text{ ft.}$$

Accordingly the cymometer enables us to measure the wave length of the radiated wave, hence its name, from the Greek word $\kappa\upsilon\mu\alpha$ = a wave.

In those cases in which we are using an antenna coupled to a closed syntonic circuit, waves of two wave lengths will be thrown off from the antenna. These waves have wave lengths given by the formula—

$$\lambda_1 = \lambda_0 \sqrt{1 + k},$$

$$\lambda_2 = \lambda_0 \sqrt{1 - k},$$

$$\text{where} \quad \lambda_0 = \frac{3 \times 10^{10}}{n_0},$$

n_0 being the natural frequency of the antenna taken alone.

In such a case the cymometer shows us not only that there are waves of two wave lengths thrown off from the antenna, but that these waves are of unequal intensity and damping. The wave which has the greatest wave length has the least damping and the greatest energy. The wave lengths of these two waves are connected with the natural wave length of the antenna taken alone by the formula—

$$\lambda_1^2 + \lambda_2^2 = 2\,\lambda_0^2,$$

and the coefficient of coupling of the oscillation transformer can be shown to be given by the formula—

$$k = \frac{\lambda_2^2 - \lambda_1^2}{\lambda_2^2 + \lambda_1^2}.$$

For certain reasons it can be shown that the best results are obtained in the case of inductively coupled antennæ when the coupling coefficient k has such a value that one of these radiated waves has three times the wave length of the other.

The damping of the two radiated waves of different wave lengths is, as already observed, different, but the decrements of the two waves are related to the decrements of the primary and secondary circuits when taken separately, and this relation has been determined by a formula, due to Drude. If δ_1 is the decrement of the primary or condenser circuit with the spark gap when taken alone, and if δ_2 is that of the antenna taken alone, then Drude has established the following relations:—

$$D_1 = \frac{\delta_1 + \delta_2}{2} \cdot \frac{n_1}{n_0},$$

$$D_2 = \frac{\delta_1 + \delta_2}{2} \cdot \frac{n_2}{n_0},$$

where D_1 and D_2 are the decrements of the two waves of wave length λ_1 and λ_2 thrown off by the antenna.

(*To be concluded.*)

A New Method of Automatic Boosting.

By Max J. E. Tilney, A.M.I.E.E.

(*Abstract of Paper read before the* Institution of Electrical Engineers *at Birmingham, January 17th*, 1906.)

There are at present some four or five methods of auto-boosting and auto-booster regulating in use with varying degrees of success.

The system here described may be of interest not only to those who are proposing to put down new stations, but also to those engineers who at present are working under difficulties with shunt-wound boosters, which they cannot afford to scrap.

The system is one of automatic regulation on the shunt field, and this regulation is automatic both when the booster is charging and discharging, the apparatus being so arranged as to provide for reversal of the shunt excitation. With unlaminated poles a regulation within 4 per cent. can be obtained on a system with a maximum load of 1,200 amperes at 430 volts with a variation of 500 amperes, representing a change from 400 amperes discharge to 100 amperes charge.

The standard apparatus is show in fig. 1, and fig. 2 is a complete diagram of the arrangement showing booster and battery.

The standard arrangement for tramway systems consists of a multiple way regulating and reversing switch, as shown in fig. 3,

mounted on a kind of table having all the resistances fixed underneath it.

The switch contact blocks are directly connected to the spindle of a small motor armature. There are two pairs, one pair making contact on rings 1 and 2, and the other pair on rings 3 and 4 in fig. 3; each pair being connected.

The reversal of the booster excitation and the discharge before reversal is effected by the two contacts marked s.s. in fig. 3, the switches as they pass on to and over these contacts short-circuiting the booster field windings. In practice, no sign of any inductive spark is visible, even with very rapid reversal.

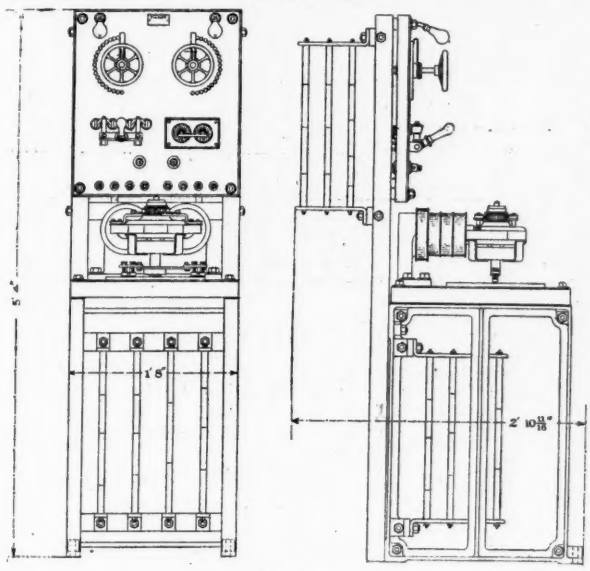


Fig. 1.

As the full boost is never required on discharge, there is a permanent resistance in series with the regulating resistance on the discharge side.

The armature has a small current always passing through it, and the pole-pieces are wound with four coils, numbered 1, 2, 3A and 3B, as shown on diagram, fig. 2.

Above and behind this table are mounted the terminals for the four field coils and the armature, two small s.p. switches and two small regulating switches with their resistances behind them, also in the standard arrangement two lampholders wired in series with the little motor armature, so that this circuit can be put across the bus-

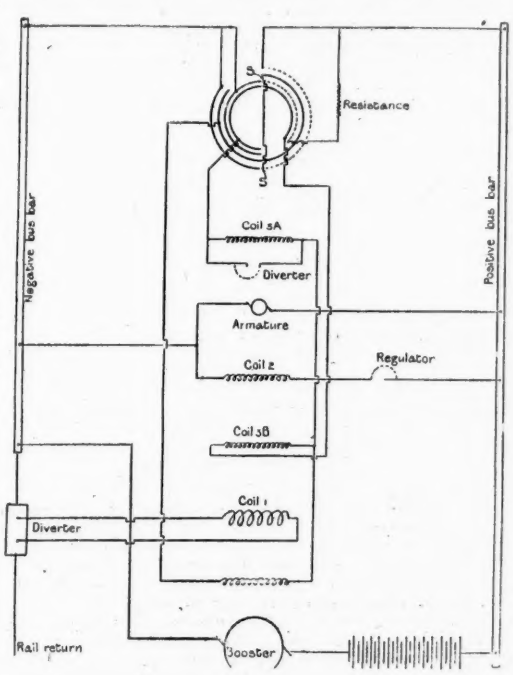


Fig. 2.

bar voltage while using a low resistance armature. One of the two s.p. switches is for this armature circuit, and the other for the circuit of the No. 2 coil, which also has one of the regulators in series with it. The other regulator is a diverter for No. 3A coil.

In the case of an old booster system being converted, the existing field-breaking switch or switches can be used; but if the apparatus is being provided for a new station, these switches will be mounted on the front of the table. The only other piece of apparatus is a main diverter capable of carrying the full output of the station, and this is in a form similar to the shunt of a moving-coil ammeter of large capacity, but of slightly higher resistance.

It will be seen that the armature *never makes a complete revolution*, and is therefore quite unlike the motor armature on a Thury regulator, which is always revolving.

The field coils are in four different circuits:—

No. 1 carries a definite proportion of the outside load diverted through it by the main diverter.

No. 2 is set to give a certain number of ampere-turns depending on the output of the machines running in the station, and this value of No. 2 coil only has to be altered when a machine is shut down or put on the bus-bars.

Coil 3A is in the circuit of the booster field when the latter is charging the battery, and coil 3B when it is discharging; the change from one to the other being effected by dividing the inside ring of the switch at the point where the booster field is short-circuited before reversal.

Coil 3A has connected in parallel with it the small diverter mentioned above. This is to compensate for the rise in volts of battery. In practice, I find that except when the cells have been considerably run down, or when it is desired to give them a gassing charge this diverter has not to be touched.

This diverter will, for practically any booster, never have to be of larger current capacity than, say, 5 amperes, and this takes the place of the costly, and as I find, sometimes dangerous diverters necessary in the case of many automatic boosters, where the main current of the station has to be carried by a variable resistance, whose value may have to be altered with considerable amounts of current passing.

The whole apparatus can be made up in standard form, and only requires the main diverter and the regulating resistances arranging for each case; the size of the main diverter, of course, being dependent on the station output, and the resistances depending on the magnetisation curve of the booster.

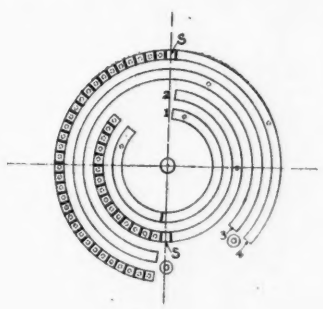


Fig. 3.

I find in practice that it is well to give a regulation of 4 volts per step on the charge side, and 3 volts on the discharge side; and it is very advisable to work out the resistances on each side carefully.

The motor armature is designed to carry about 0·5 ampere, and its best figure is somewhere in the neighbourhood of 0·3 ampere.

No. 1 coil on the field is arranged to carry 50 amperes as a maximum, at the maximum output of the station, and it has 40 turns, so its maximum value is 2,000 ampere-turns.

Coil 2 has 1,000 turns, and a current capacity of 2 amperes.

The current in this coil is varied by means of the regulator mentioned previously, and its ampere-turns value can be varied from 100 up to 2,000 in the 20 steps provided.

These two coils will be the same whether the station in question has a top load of 100 amperes or 5,000; in the former case half the load would be diverted through No. 1 coil, and if the generator output was 50 amperes, the value of coil No. 2 corresponding to it would be 1,000 ampere-turns, and in the second case only $\frac{1}{100}$th of the output goes through No. 1 coil, and the value of coil No. 2, corresponding to a generator output of, say, 400 amperes, would be 1,600 ampere-turns.

Coil 3A has 1,000 turns and a current capacity of 2·5 amperes.

Coil 3B has 2,000 turns and a current capacity of 2 amperes.

The operation of the apparatus depends on the fact that any movement of the switch not only alters the booster field, but also alters the value of coils 3A or 3B, always tending to produce a resultant zero flux in the small motor field system.

Coils 1 and 2 are always producing a magnetising effect in opposition to one another. Coil 3A acts in the same sense as coil 1, and therefore the switch tends "on charge" to set itself in such a position, that the flux due to coils 1 and 3A is equal to the flux due to coil 2.

On discharge, coil 3B comes into action (coil 3A is out of circuit), and coil 3B acts in the same sense as coil 2, and the switch tends to set itself so that the flux due to coils 2 and 3B is equal to that due to coil 1.

The switch operates with a difference of about 50—0—50 ampere-turns—that is, the limits of variation in the load without the switch

= 200 × 0 ft.

multiple way regulating and reversing switch, as shown in fig. 3,

moving would be 100 amperes, being 50 ampere-turns on either side of the absolute zero field on the small motor.

If it is desired to use the battery and booster without any generating plant running, it will be quite clear that if the S.P. switch controlling No. 2 coil is opened, Coils 1 and 3B will try and balance each other and the boost-out will depend directly on the outside load, any variation making a corresponding variation in the resistance in the booster shunt field, and also in the ampere-turns due to Coil 3B.

The size of the station makes no difference whatever, as the percentage of load variation at which the regulator begins to operate is the same in all cases, so that in a small plant the small variations which then amount to 1 per cent. of maximum load will be dealt with as smoothly as the 1 per cent. variations in load of a 5,000-KW. station.

I find that with solid cast-steel poles on the booster the switch generally rather overshoots its mark, and then comes back. This is particularly the case with large variations in load, but is an advantage, as it helps to make the excitation follow the shunt current a trifle quicker than it will do with the switch going direct to its proper position.

To overcompound so as to compensate for drop in feeders it is only necessary for the value of Coil 2 to be set a little below the capacity of the plant running, and to divert Coil 3A by a slightly lower resistance. I have been able to raise the volts on a small system to 520 when the load comes on, and reduce them to 500 when it goes off, so that the cars have been able to keep better time at the busy part of the day than they had previously been able to do.

The next point to consider is the question of efficiency and general running losses. The latter may be put down as consisting of:—

1. Current in small motor armature.
2. Current in No. 2 coil.
3. Volt drop on main diverter and No. 1 coil.
4. Copper loss No. 3A and 3B coils.

Of these, No. 4 may be ignored; the resistance of No. 3A is about 5 ohms, and of 3B about 12 ohms.

Loss No. 3 is also quite small, as the resistance of the main diverter is, for a 2,000-ampere station, only about 0·00015 ohm, the series coil resistance being about 0·009 ohm, so that at top load the loss would only be 1,000 watts.

Loss No. 2 would at full load in this case be 1·2 × 500 = 600 watts, and loss No. 1 would be 0·3 × 500 = 150 watts, making a total *at maximum load* of 1,750 watts.

A very fair average load factor for a tramway station is 25 per cent., so that the average losses due to the regulator would be, say, 450 watts. The efficiency of the arrangement may therefore be considered as the efficiency of the booster and its motor.

I do not claim for this arrangement the very high efficiency claimed for the Highfield booster, but I am of opinion that too much can be paid, in first cost, for a small gain in efficiency, particularly when it means putting out of service, plant which is already installed.

The total cost for a traction station will not exceed £80 for regulating a booster up to 40 KW. capacity in a station with an output of about 3,000 amperes, as a maximum, and the cost for larger boosters is simply dependent on the regulating resistances required and the capacity of the main diverter for the No. 1 coil.

In the case of a three-wire network with two boosters, two regulators will, of course, be necessary, unless, as is sometimes done, the battery middle wires are taken out and the booster fields are coupled in series and the armatures also coupled in series, which practically makes the system a two-wire one as far as battery and boosters are concerned, leaving the balancers to deal with any out of balance that may come on.

After reading his paper, Mr. TILNEY gave some additional information relating to a regulator which was in actual use at the tramway power station of the Urban Electric Supply Co., of Glossop. A 4-pole shunt-wound booster with laminated pole-pieces was used. The maximum load on the system was about 400 amperes, and the line pressure 500 volts. A 45-KW. set and a battery capable of discharging up to 350 amperes had been installed, but in order to keep up the pressure to anything like 500 volts when peak loads came on, it had been found necessary to use an additional set of 90 KW. capacity. By using the regulator they were now able to carry the heaviest load with the small set, and there was no necessity to run on for charging purposes except one night a week, when they gave the battery an hour's gassing charge.

While keeping the load on the machine about constant, it was possible to regulate from 65 amperes charge up to about 180 discharge, with an extreme variation of 16 volts.

Mr. J. S. HIGHFIELD, in a written communication, pointed out that in laying out a battery equipment to work on a variable load, so that the generators might run at approximately constant load, it was important that the battery should be of proper size for the work, whatever system of boosting or regulating might be used. It was not a fact that, as a concern grew, a larger battery was necessarily required. The conditions were different to a lighting load, where the battery should be properly increased as the load increased. In the case of loads where automatic regulation was required, the battery could be laid out so that it would be sufficient for years, since, as the load grew, in nearly every case its load factor improved.

Mr. R. S. MCLEOD wrote saying that there was no heavier work for a booster than a traction system, where the load varies from 0 to 100 per cent. overload continually, and unless the machine had been specially designed for this class of work, it was liable to give a great deal of trouble through sparking; laminated fields were practically a necessity to follow up the peaks of a tramway load quickly enough.

Mr. VICTOR BORNAND said that the $\frac{1}{10}$-H.P. pilot motor of the Thury regulator ran at from 2,000 to 2,500 r.p.m. This speed resulted in a very quick motion of the gear actuating the field rheostat brush. Mr. Tilney was mistaken in stating that the Thury regulator never automatically reversed the shunt field; this was actually one of its principal duties. Under the conditions stated, the Thury regulator would keep the voltage constant within $\frac{1}{2}$ or even $\frac{1}{4}$ per cent. In his opinion, an automatic reversible booster should need no hand regulation. He considered that the losses in Mr. Tilney's regulator were considerable. The small motor of the Thury regulator consumed only 90 watts at all loads.

Mr. ARMISTEAD (Wolverhampton) said that Mr. Tilney's apparatus gave satisfactory results when used with a simple shunt-wound booster. It enabled the battery to be charged any day, and it was fool-proof.

Mr. G. C. ALLINGHAM (London) said that in principle Mr. Tilney's system was practically that of the ordinary differential booster worked through a relay, the differential coils being wound on the field magnets of a subsidiary motor. The system had the advantages that the initial cost and the losses in the various coils were reduced; but these advantages were gained at the expense of the regulation. Most reversible boosters had a compound winding, which compensated for the drop in the battery, booster, &c., and which could easily be used for over-compounding.

Dr. D. K. MORRIS said that the principle of Mr. Tilney's regulator was the same as that of the Thury regulator, and gave some figures relating to the reversible booster and regulator of the Thury pattern, which had recently been installed in the electrical laboratory of the University of Birmingham.

Mr. W. FENNELL (Wednesbury) said that the average efficiency of a booster was probably only about 50 per cent. It was important that the whole magnetic circuit of a booster should be laminated, the yoke as well as the pole-pieces. Many booster troubles were due to variations in the motor speed.

Mr. M. B. BEYER said that Continental engineers did not favour the use of automatic and reversible boosters, which were as troublesome as the batteries themselves. The money would be more profitably spent in increasing the capacity of the battery.

Mr. S. H. HOLDEN referred to Mr. Tilney's statement that the loss in the regulator at full load was 1,750 watts, and at quarter-load 450 watts. A large portion of the loss seemed to be made up of fixed quantities, and he thought that the loss at quarter-load would be about half rather than a quarter of the full load losses.

Mr. TILNEY, in reply, said that in many small tramway stations, it was not possible to keep the cell voltage at a figure to obtain results suggested by various speakers, as it was quite an ordinary occurrence in these stations for the cell voltage to rise to 2·5, and it was just the rapid fluctuation of the cell voltage from 2·5 down to 2 volts, which had caused most of the trouble in connection with automatic boosting arrangements. There was no necessity in this regulator, to adjust the series diverter when once it had been fitted up, and the small adjustment necessary to get the right proportion of the outside load diverted through No. 1 coil was easily made. The regulation of 4 per cent. which he quoted, was 2 per cent. on either side, not 4 per cent. on either side. What tramway engineers required was not a straight line curve in the station, but a straight line curve on the trolley line. The ease with which his regulator could be made to compound up was a great advantage. Watching the line voltmeter and total current ammeter as well as an ammeter in circuit with the No. 1 coil, he found that the ammeter in circuit with the No. 1 coil did not appreciably lag in action behind the ammeter of the main circuit, and though in the event of a very heavy load being thrown on, there was a momentary swing on the voltmeter, the needle returned to its original position in a second, the little armature of the regulator motor almost moving with the swings of the main ammeter needle. Replying to Mr. McLeod, he said that in practice it was quite an ordinary thing to have to commence a charge with full current and practically no boost on the machine at all. With the regulator in question, he was able to keep the load on the generators constant within 10 amperes. The regulator had only been in use about three weeks, but he did not anticipate any trouble. There was nothing to get out of order, and all that was required was for the contacts to be wiped over with a little rag and methylated spirits, say, twice a week. Replying to Mr. Highfield, he did not intend to convey in any way that a larger battery was necessary as the load grew. Unfortunately, they could not always put in a battery as big as they would like; he supposed that there was a certain economic figure beyond which it was not advisable to increase the size of a battery for a given load, and in order to obtain satisfactory regulation with the smaller battery, it was more advisable to spend, say, an extra £300 on a booster than to spend a couple of thousand pounds on larger cells.

Mr. H. SIDDELEY, in a written communication, doubted whether the average booster was suitable as an automatic reversible machine. Even if it were, it would be cheaper to re-wind the fields after the method used by Turnbull and McLeod, and certainly simpler than introducing a new machine and automatic switchgear. He did not agree with Mr. Tilney that in practice his regulator with a solid field booster would pick up the peaks quickly enough. The use of diverters in the main circuit made the booster rather more sluggish than if the whole current passed through the series winding. The volts varying in fixed steps of three or four would also not give a gradual enough regulation when the battery was fully charged.

Mr. Tilney replied that, as regarded laminated fields, he expressly stated that regulation was better with them. He doubted whether it would be possible to rewind a booster on the T. & M. principle, unless the carcass was much larger than was needed in the first instance. As regarded sluggishness due to diversion, it did not appear to affect the apparatus as far as he could observe. He did not consider that a battery was nearly fully charged till the cells rose to 2·5 volts, and at this figure much coarser regulation was permissible, as it took a much greater variation in volts to produce a change from, say, 100 amperes charge to 200 discharge when the cells were up to 2·5 than was the case when the cells were at, say, 2·2 volts.

Physical Society.

At the meeting held on January 26th, 1906, Prof. J. H. Poynting, F.R.S., President, in the chair, a paper on "The Isothermal Distillation of Nitrogen and Oxygen and of Argon and Oxygen," was read by Mr. I. K. Inglis.

A paper on "The Use of Chilled Cast-Iron for Permanent Magnets," was read by Mr. A. Campbell. The present investigation was made on rings in addition to rods of the standard dimensions usual in testing magnet-steels. All the specimens were heated to 1,000° C. and then chilled in cold water, care being taken to support them during the process, as cast-iron is very brittle at such a high temperature. The rods were tested for maximum remanent B and coercivity by Madame Curie's method. The results showed the chilled cast-iron to be not very inferior to ordinary magnet-steel. Permeability curves indicated that the simple process of chilling used was quite satisfactory even for a tolerably massive ring of 6 sq. cm. cross-section. The cheapness and ease of working cast-iron should encourage instrument-makers to test its capabilities in various instruments. The iron used was grey commercial cast-iron.

A paper by Prof. Lyle and Mr. Baldwin, "On Experiments on the Propagation of Longitudinal Waves of Magnetic Flux along Iron Wires and Rods," was read by Prof. F. T. Trouton. The experiments described in the paper were undertaken with the object of determining whether there was a definite rate of propagation of magnetism in iron. Contrary to what had been observed in previous researches, the authors found that the phase lag, instead of continuously increasing along the bar, reached a maximum value and then diminished, proving the absence of true wave propagation.

ADVANTAGES OF ELECTRIC MOTORS FOR DRIVING INDUCED-DRAUGHT FANS.

[COMMUNICATED.]

To dilate upon the advantages of electric motors, compared to steam engines, for driving auxiliary plant in central stations nowadays, may seem superficially to resemble the process of flogging a dead horse, but, looking a little deeper, it appears that motors have not yet displaced their rivals so far as their advantages appear to warrant. This being so, it is worth while to consider again, besides the ordinary advantages of the electric motor, the special advantages in connection with the driving of fans for boiler draught, and, with this in view, the following observations are made, based on experience with up-to-date induced draught plant.

The usual type of engine for fan driving is a high-speed enclosed engine, with splash lubrication, direct-coupled to the fan, and more often than not it has a single crank, as the sizes in common use range about 20 H.P. The fan, generally centrifugal in action, is overhung from a water-cooled bearing.

A suitable type of motor for the same service is a multipolar series-wound machine, with speed regulation obtained by shunting the field coils by means of a switch connected to a resistance, which can be cut out to the desired extent. Thirty per cent. range in speed is a convenient one, and can readily be obtained in this manner in eight to ten steps. The fan itself is identical with that used with the engine.

The first consideration is the capital cost, and the advantage is with the motor by about 25 per cent., considering the driving mechanism only, the fan being, of course, the same in both cases.

Next, taking reliability as regards freedom from breakdown, it is rather difficult to make a comparison, but, taking them as on an equal footing, if there is any doubt it is certainly in favour of the motor, and, further, from the attentions required by the engine, it is quite certain that it has to be shut down more frequently than the motor, and thus the advantage of all-round reliability is distinctly with the latter. Now, coming to cost of operation, the power supplied to the engine is direct from the boilers, whereas for the motor the power, starting from the boiler, goes to the main engines, generators and cables, in succession, involving more stages of losses. This may appear to be in favour of the engine, but for the consideration that the small fan engine is a far less efficient machine than the main generating set, and also uses steam in warming up and in condensation in steam piping, whereas the motor has no loss corresponding to the former and smaller losses corresponding to the latter, and, as a matter of fact, there can be but little difference in the power required in the two cases.

It is in the cost of attendance, repairs and renewals, that the motor has its principal advantages.

The engine must be looked to several times daily for lubrication of the cylinder, and occasionally oil or water must be added to the crank chamber mixture.

Glands, of the various kinds, five or six in all, require taking up and repacking, brasses require letting together, &c., at periods varying from a few weeks to as many months, and cost proportionately in labour and material.

A motor entails no more cost for running than is included in the renewal of brushes about once a month, and in the changing of a quart of oil in the two bearings, the old oil being still of service after filtering.

From the nature of their work, the motors or engines will be much exposed to dirt in the form of coal dust and grit, but both are amply protected by being of the enclosed type. As it is a considerable advantage to use a motor of the open type, a rather smaller motor, doing the same work as one of the others, where possible, it is an excellent plan to have the motors mounted on brackets in the engine room against the boiler house wall, connecting up to the fans by extension shafts through holes in the wall.

The kind of accident, perhaps, most liable to happen to this plant is for the fan to slip on its shaft and foul its housing; if this happens, then, before the fouling can get so bad as to put a serious strain on any part, the excess current circuit-breaker of the motor will operate and shut off the supply of energy. With an engine, it is much more likely that damage will be done in such a case, as the fan will go on working until it absolutely jams, and then the pressure will be kept on by the engine.

One of the special advantages of the motor in connection with maintaining the supply lies in the fact that so long as the voltage at its terminals is kept up, it will continue to run at the constant speed for which its regulator is set. Now the speed of a fan engine will vary with the boiler pressure, and in case of steam pressure dropping, owing, say, to sudden load coming on, or temporary breakdown of stokers (mechanical or otherwise), the fans will proceed to slow up just at the time they are required to do the reverse, and thus make the situation worse. With a motor the case is quite different. Steam pressure will have to drop considerably, say, 25 to 30 per cent., before the main generators commence to drop their voltage, and until this point is reached, not only do the fans continue to be driven at a constant speed, but the maximum speed is available, if required, in a few seconds' time, and this is a very real benefit.

Again, consider another case, which occurs occasionally in all traction supply stations, and is not quite unknown in lighting supply systems, that is, where the whole supply is suddenly cut off by the main generator circuit-breakers coming into action, and it will be a minute or two before the supply can be resumed, and then, perhaps, not entirely for several minutes.

Where motors are installed they shut down at once, and the starting switch is opened by failure of the supply: thus the boilers are relieved of draught simultaneously with the lifting of the load, tending to reduce to a minimum the blowing off of steam which takes place then. When the supply is resumed, the fans can be quite easily started up as the load comes on. The process of dropping dampers and shutting down engines is a much more tardy and ineffective way of dealing with such a case, to say nothing of the extra trouble.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

1,688. "Improvements in and relating to a device for the production of electrolyte metal plating." A. SCHMITZ. January 22nd. (Complete.)

1,688. "Electro-magnet cork extractor." J. BARR. January 23rd.

1,691. "Improvements in dynamo-electric machines." S. VON AMMON January 23rd.

1,695. "Improvements in and relating to automatic electric signalling for use on electric tram, railways or the like." C. J. SPENCER. January 23rd. (Complete).

1,699. "Improvements relating to electrically-fired internal-combustion engines." H. PIEPER. (Date applied for under Patents Act, 1901, January 24th, 1905, being date of application in Belgium.) January 23rd. (Complete.)

1,707. "Improvements in sectional ambulance stretchers, drain cleaning tools, chimney cleaning tools, pulling through rods, for electrical conduits, and the like." G. DAVIS, W. DAVIS and S. DAVIS. January 23rd. (Complete.)

1,712. "Improvements in telephonic apparatus." E. A. GRAHAM. January 23rd.

1,713. "Improvements in or relating to telephonic apparatus." E. A. GRAHAM. January 23rd.

1,714. "Improvements in or relating to means or apparatus for supplying electric current to telephonic apparatus." E. A. GRAHAM. January 23rd.

1,716. "Improvements in or connected with electrolytic cells." R. H. F. FINLAY and A. H. FINLAY. January 23rd.

1,728. "Improvements in or relating to electric alarm devices." A. LOEBL. January 23rd. (Complete.)

1,738. "Improvements in electric switches." C. A. ALLISON. (The Empire Electric Stage Lighting Co., United States.) January 23rd. (Complete.)

1,763. "Improvements in or connected with electric batteries." W. H. FELLOWS, E. T. PICKUP and W. TICE. January 23rd.

1,766. "Electrode for arc lamps." O. KONITZER. (Date applied for under Patents Act. 1901, January 23rd, 1905, being date of application in Germany.) January 23rd. (Complete.)

1,783. "Protecting-cap for the electrodes of sparking-plugs." J. ALDIGIER. January 24th. (Complete.)

1,785. "Improvements in and relating to sparking-plugs." J. SEGUINIOL. January 24th. (Complete.)

1,786. "Improvements in and relating to driving gear for use with electric, petrol or steam or like motors or engines." F. DOUGILL. January 24th.

1,793. "Anode suspender and rod and cable clip for transmitting electricity for use in the electro-deposition of metals and as connector in the use of electric light cables and the like." J. MIDDLETON. January 24th.

1,796. "Improvements in and relating to electrical fuses." A. C. LIVESEY. January 24th.

1,804. "Improvements in or relating to means for rendering certain substances and materials waterproof, non-inflammable and non-conductive of electricity." H. D. HAIGH, P. WHEELER and W. APPLEYARD. January 24th. (Complete.)

1,810. "Improvements in tumbler switches." E. T. DAVIES. January 24th. (Complete.)

1,818. "Improvements in electric switches for electric traction on the surface contact system." R. BROWN. January 24th.

1,830. "Improvements in connection with the control of the electric circuits in systems of electric traction." A. RAWORTH. January 24th.

1,847. "Improvements in or connected with electrical sparking or ignition apparatus for internal combustion engines." A. WESTMACOTT and W. F. THOMAS. January 24th.

1,852. "Improvements in apparatus for measuring temperatures by electric resistance thermometers." SIEMENS BROS. & Co., LTD., and A. GORDON. January 24th. (Complete.)

1,867. "Improvements in and relating to electrically-operated signals for railways, tramways and the like." THE ALLGEMEINE ELECTRICITATS GESELLSCHAFT. (Date applied for under Patents Act, 1901, January 25th, 1905, being date of application in Germany.) January 24th. (Complete.)

1,868. "Improvements in and relating to submarine telegraph cables." E. STALLIBRASS. January 24th.

1,881. "Improvements relating to electrical fuses and boxes therefor." VERITYS, LTD., and A. E. GOTT. January 25th.

1,901. "Improved interrupter for electrical ignition on cycles driven by internal combustion engines." J. J. BARTER and LIGHT MOTORS, LTD. January 25th.

1,902. "Improved contact-breaker for the electrical ignition of internal combustion engines." J. J. BARTER and LIGHT MOTORS, LTD. January 25th.

1,914. "Improvements in or connected with apparatus for protecting telegraph and like lines from the effects of lightning discharges." J. C. FULLER and G. FULLER. January 25th.

1,924. "Electrode for storage batteries." T. A. EDISON. (Date applied for under Patents Act, 1901, November 2nd, 1905, being date of application in United States.) January 25th. (Complete.)

1,925. "Storage battery electrode." T. A. EDISON. (Date applied for under Patents Act, 1901, March 30th, 1905, being date of application in United States.) January 25th. (Complete.)

1,927. "Electrode mass for storage batteries and process of forming the same." T. A. EDISON. (Date applied for under Patents Act, 1901, March 30th, 1905, being date of application in United States.) January 25th. (Complete.)

1,928. "Storage battery electrodes." T. A. EDISON and J. W. AYLSWORTH. (Date applied for under Patents Act, 1901, April 28th, 1905, being date of application in United States.) January 25th. (Complete.)

1,934. "Improvements in and relating to arrangements for telephone service systems and methods of operating the same." W. OHNESORGE. (Date applied for under Patents Act, 1901, January 28th, 1905, being date of application in Germany.) January 25th. (Complete.)

1,944. "Improvements relating to systems of laying electric conductors." J. S. HIGHFIELD. January 25th.

1,945. "Improvements in safety devices applicable to electric high-tension direct-current systems." J. S. HIGHFIELD. January 25th.

1,946. "Improvements relating to high-tension direct-current electric systems." J. S. HIGHFIELD. January 25th.

1,947. "Improvements in or relating to systems of direct current electric supply." J. S. HIGHFIELD. January 25th.

1,963. "Improvements in or relating to electricity meters." W. M. MORDEY and G. C. FRICKER. January 25th.

1,968. "Improved process for the electro-deposition of alloys." S. O. COWPER-COLES. January 26th.

1,983. "Improvements in the sparking devices of internal combustion engines." R. C. PESSELL. January 26th.

1,987. "Improvements in the construction of ignition plugs for internal combustion engines." P. W. FAWCETT. January 26th.

1,989. "Improvements in self-recording electric meters." A. W. BROWN. January 26th.

1,992. "Improvements in electrical apparatus for lighting gas." M. NEHMER. January 26th.

2,014. "Improvements in electric arc lamps." G. D. MANTLE. January 26th.

2,019. "Improvements in and connected with electric relays and recorders." H. W. SULLIVAN. January 26th.

2,027. "Improved method and means for controlling electro-magnets and the like." H. C. E. JACOBY. January 26th.

2,037. "Improvements in trolley wheels for collecting and conveying electric current to trams and like electrically-driven vehicles." I. HEY and T. BROADBENT. January 26th.

2,035. "Improvements in and relating to electric controllers." THE BRITISH THOMSON-HOUSTON CO., LTD. (The General Electric Co., United States.) January 26th.

2,036. "Improvements in and relating to insulated conductors and windings suitable for use in the construction of transformers, dynamos and other electrical apparatus." A. F. BERRY. January 26th.

2,037. "Improvements in the construction of electro-magnets." A. F. BERRY. January 26th.

2,038. "An improved method and apparatus for treating textile fibrous materials with the products of the electrolysis of water, solutions of acids, oxides and salts." H. HEY. January 27th.

2,100. "A new form of electroscope for measuring X-ray radiation." H. C. NEWTON. January 27th.

2,129. "Improvements in electric resistance elements." A. J. BOULT. (A. L. Marsh, United States.) January 27th. (Complete.)

2,151. "Improvements in rotating magnets for dynamo-electric machines." THE HON. C. A. PARSONS, G. G. STONEY and A. H. LAW. January 27th.

2,153. "Improvements in and connected with hoisting apparatus for electric arc lamps." J. NEU. January 27th.

2,158. "Improvements in and relating to electric measuring instruments." THE BRITISH THOMSON-HOUSTON CO., LTD., and F. HOLDEN. January 27th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1904.

METHOD OF AUTOMATICALLY REGULATING THE VOLTAGE IN ELECTRIC LIGHT AND POWER CIRCUITS WITH VARYING LOADS. M. J. E. Tilney. 27,168. December 13th.

ARC LAMPS. G. M. Zingel, W. Wolf and A. Reiner. 27,437. December 16th.

AUTOMATIC ELECTRIC CELL SWITCHES. Elektricitäts-Akt.-Ges. Westphalia and Kupferschlag. 27,859. December 20th.

SYSTEMS OF ELECTRIC DISTRIBUTION AND CONDUCTORS THEREFOR. B. Gati. 28,468. December 27th.

ELECTRIC SWITCH AND CIRCUIT BREAKER. J. A. Hirst and P. S. Brook. 28,858. December 30th.

ELECTROLYSING APPARATUS. E. L. Thorp. 25,839. November 28th.

MEANS FOR AUTOMATICALLY CONNECTING UP WITH EACH OTHER THE SUBSCRIBERS TO TELEPHONE EXCHANGES. J. Peticky, J. Cizek and F. Suchanek. 28,036. December 21st.

ELECTRIC TELEGRAPHS. E. Ritchie. 28,254. December 23rd.

ELECTRICAL RELAYS. E. Ritchie. 28,255. December 23rd.

WORKING OF TELEPHONIC SYSTEMS. R. L. Murray and F. J. Jackson. 28,329. December 27th.

MEANS FOR THE MUTUAL ELECTRICAL CONTROL OF OPPOSITELY ROTATING MEMBERS OF TURBINES. J. H. Davies and M. Blieden. (Date applied for under Rule 5, Patents Rules 1905, December 30th, 1904.) 29,082A. December 30th.

ELECTRIC APPARATUS FOR SWITCHING ON AND OFF LAMPS, ESPECIALLY APPLICABLE FOR USE IN "FLASH" ADVERTISING. L. Job. 29,126. December 30th.

HEAT INSULATING COVERINGS. C. Brader. 29,349. December 31st.

INDUCTION COILS. H. W. Sullivan. 29,368. December 31st.

ELECTRICAL APPARATUS FOR TRANSMITTING AND RECEIVING SIGNALS. A. T. Dawson and G. T. Buckham. 29,422. December 31st.

TELEPHONE AND LIKE PLUG CORDS. W. G. Inglefield. 29,645. December 31st.

1905.

ELECTRIC IGNITION GEAR FOR EXPLOSION MOTORS. G. Cornilleau and A. Sainte Beuve. (Date applied for under International Convention, December 29th 1904.) 14,318. July 11th.

ELECTRICAL RELAYS. C. G. Roos and C. B. Roos. 17,955. September 5th.

MAGNETO-IGNITION APPARATUS FOR USE WITH INTERNAL COMBUSTION ENGINES. J. Gawron. (Date applied for under International Convention, August 26th, 1904.) 17,280. August 26th.

AMPERE-HOUR MOTOR METERS. Allgemeine Elektricitats Ges. (Date applied for under International Convention, October 28th, 1904.) 21,672. October 24th.

ELECTRIC SWITCHES. Electric Ignition Co., Ltd., and F. H. Hall. 22,585. November 4th.

MEANS FOR REGULATING THE SPEED OF ELECTRIC MOTOR-CARS. L. Krieger and Cie Parisiennes des Voitures Electriques. (Procedes Krieger.) (Date applied for under International Convention, December 1st, 1904.) 22,723. November 6th.

MANUFACTURE OF INCANDESCENCE BODIES FOR ELECTRIC LIGHT. Siemens and Halske Akt.-Ges. (Date applied for under International Convention, November 15th, 1904.) 23,097. November 10th.

MANUFACTURE OF GLOW LAMPS WITH INCANDESCENCE BODIES OF TUNGSTEN MOLYBDENUM OR SIMILAR METALS. Siemens & Halske Akt.-Ges. (Date applied for under International Convention, November 15th, 1904.) 23,098. November 10th.

ELECTRIC ARC LAMPS. British Thomson-Houston Co., Ltd. (General Electric Co.) 80. January 2nd.

"PARTY LINE" SYSTEM OF TELEPHONES. H. B. Stocks. 1,698. January 27th.

STARTING AND CONTROL OF DIRECT CURRENT ELECTRIC MOTORS. Heath. 2,401.

CONTROLLING DEVICES FOR ELECTRIC MOTORS. W. Fairweather. (Diehl Manufacturing Co.) 3,564. February 24th.

CONDUITS FOR ELECTRIC CONDUCTORS OR CABLES. T. E. Devonshire. 4,456. March 3rd.

ELECTRIC CLOCKS OR THE LIKE. F. A. Chandler and B. Bonniksen. 4,513. March 4th.

ELECTRIC PUSHES OR SWITCHES FOR OPERATING ELECTRIC BELLS, TELEPHONES, SIGNALLING, AND FOR OTHER PURPOSES. C. S. Wansborough. 4,791. March 7th.

APPLIANCES FOR TESTING ELECTRIC BATTERIES. H. H. Lake. (N. Jacobsen.) 4,780. March 7th.

CONSTRUCTION OF CONDUITS FOR CONTAINING ELECTRIC CABLES AND WIRES, AND OTHER WIRES, TUBES, PIPES AND THE LIKE. W. Hepworth-Collins. 5,865. March 20th.

ALTERNATING CURRENT DYNAMO-ELECTRIC MACHINES. British Thomson-Houston Co., Ltd. 5,980. March 21st.

ELECTRICAL SIGNALLING APPARATUS PARTICULARLY ADAPTED FOR SIGNALLING IN MINES. L. B. Woodworth. 10,794. May 23rd.

MEANS FOR SUSPENDING AND SUSTAINING ELECTRIC LAMPS AT ANY DESIRED HEIGHT. W. Whitaker and A. B. Wass. (Date applied for under International Convention, July 14th, 1904.) 14,441. July 13th.